Eyebot™ Manual

HD2 Version

Version Apr 4, 2001

HARDWARE

SIGHTech Vision Systems, Inc.

650 Saratoga Ave.

San Jose, CA 95129.2051

tel 408.557.6773 • 800.992.4188

fax 408.557.6799

email: Info@SIGHTech.com • www.SIGHTech.com

SOFTWARE

Absolute Machine Vision

1264 Eighth Ave.

San Francisco, CA 94122

tel 415.661.8068 • www.absolutemachinevision.com

TABLE OF CONTENTS

OVERVIEW

Eyebot HD-2 Inspection System was developed specifically for IBM to inspect cassettes of hard drive disks on a conveyor system. The objective is to detect missing, crossed, or doubled disks in any of the available cassettes slots.

The inspection system is overviewed in Figure 1. The inspection system will be mounted onto IBM's Conveyor system as shown in Figure 2.
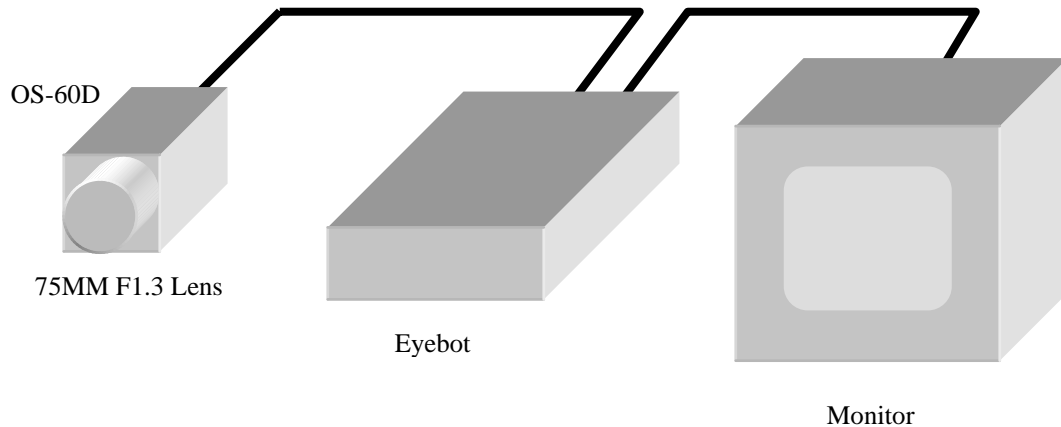

OS-60D

75MM F1.3 Lens

Eyebot

Monitor

Figure 1   Overview

A video camera is mounted over each conveyor track. To increase video resolution without requiring expensive high-resolution cameras, the camera lens focuses on only a small section of the cassette. The camera is set at a particular angle to see both the cassette's ribs (which separate the slots) and the disks within the cassette. In Figure 2 the left side camera looks at the right side track and the right camera looks at the left track. The Eyebot software detects and counts ribs as the cassette passes through the camera view. Eyebot is measuring disk thickness, checking for double disks, disk slant, and crossed disks. The Eyebot software also detects the size of the disks, 65MM, 70MM, 84MM, or 95MM because the conveyor lines will contain a random variety of all four.

Backlighting is used to simplify the video image and reduce the effects of stray reflections.

Figure 2   Cassettes and Cameras

INSTALLATION

The most critical part of the installation is the alignment of the camera.   The
Eyebot HD will not operate at all if the alignment is not just so.   From trial
and error, SIGHTech has developed a procedure that gives good results.

Definition of Roll, Yaw, and Pitch

When aiming the camera, we use the aeronautical terms of roll, yaw, and pitch to
describe the attitude of the camera. Imaging an airplane flying above and
opposite to the moving direction of the cassette motion. Roll is the rotation
of the airplane around its long axis, yaw is change in heading, and pitch is the
nose up and down.

Visualize a camera mounted under the belly of that airplane and aimed downward
to the ground. Applying a Cartesian Coordinates to describe our camera and
conveyor system, X is the opposite of motion direction of the track, Y is the
horizontal axis perpendicular to X, and Z is the vertical upward direction, as
shown in Figure 3. The XYZ are defined the same as those marked on the IBM
camera mount.

A roll motion rotates the camera around the X-axis.

A yaw motion equals the camera rotating around the Z-axis and causes features of
the cassette ribs to appear higher on one side than on the other side of the
monitor screen.

Motion in pitch causes the camera to look up and down the track instead of
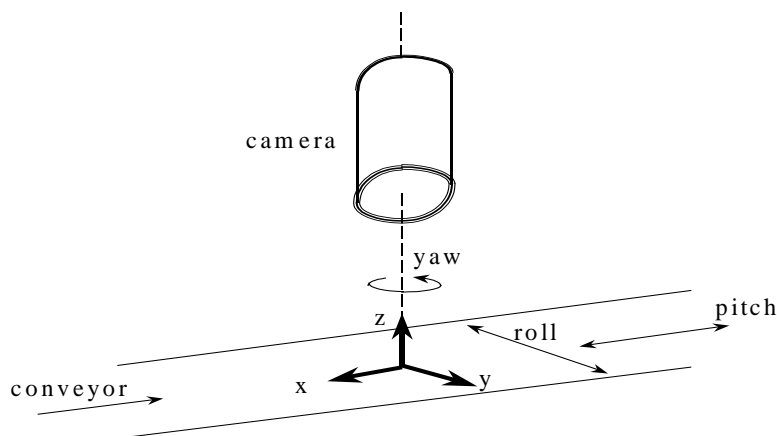straight down onto the top of the cassette.

Figure 3   Roll, Yaw, and Pitch

Mounting the Camera

The camera angle is critical since the Eyebot is looking for a particular silhouette from the cassette ribs. If the vertical height of the camera above the cassette and distance horizontally away from the cassette is carefully adjusted, then the camera angle is well defined. The height of the **camera's mounting hole** should be **36 inches above the top of the rollers** of the track. Drop a plumb line from the camera's mounting hole.   This plumb line must be **9.5 inches away from the center** of the disks. We suggest that when you begin to mount the camera, set all the adjustable screws, X, Y, A, B, and C to the middle, and rotation around Z-axis to zero. Turn the camera, the Monitor, the Eyebot, and the backlighting on, and turn the knob on the Eyebot to TEST. Focus on disks; the track wheels will remain blurry.

Since the Eyebot needs to view the silhouette of the ribs of the cassettes with backlighting that will be mounted under the conveyor, and conveyor drive wheels may interfere, we want the camera to view the spot exactly between two wheels. We suggest that you mark this spot and drop a plumb line so that the mounting hole of the camera can be placed above and in line. This will help you aim the camera directly between the wheels. Adjust X, Y, Z, and C to make four wheels appear evenly on the monitor screen corners, as shown in Figure 4.

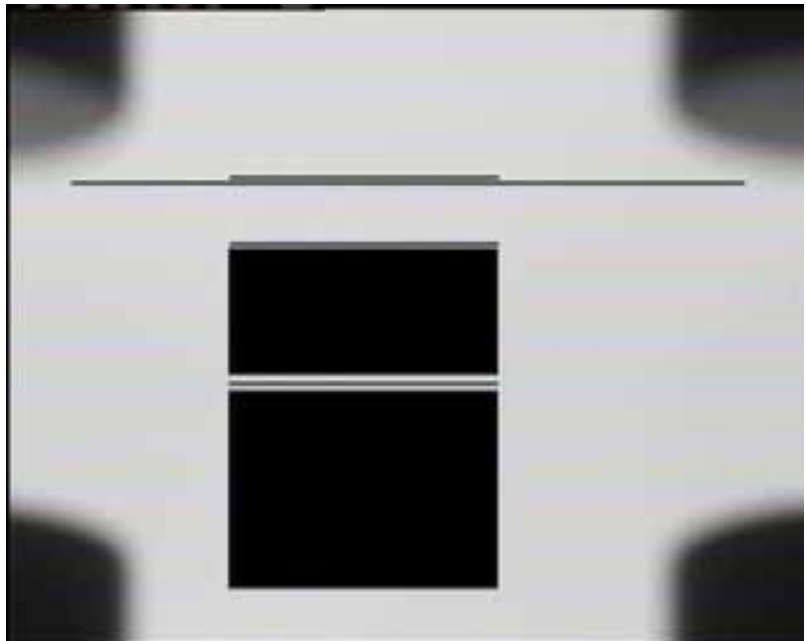**Figure 4   Camera Aimed Between Roller**

The black square window with a line inside is the Rib Detection Window. The ribs must pass within this window. The lines inside and outside of the Rib Detection Window are the Data Collecting Lines and will be explained later in this manual.

You may need to shorten or otherwise modify the drive or idler wheels of the conveyor to get a clear camera view.

6

Adjusting The Roll Of The Camera

Place a 95MM cassette on the track and adjust knob C to make the ribs entirely
visible but just at the bottom of the Rib Detection Window. Place a 65MM
cassette on the track and adjust C again if necessary to make sure the ribs are
within the Rib Detection Window. You may need to repeat checking on 95MM
cassette and 65MM cassette. The different size cassettes should appear on the
screen as in Figure 5,Figure 6,Figure 7 and Figure 8.

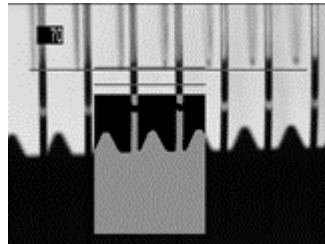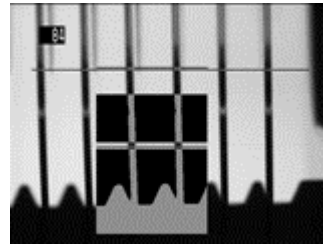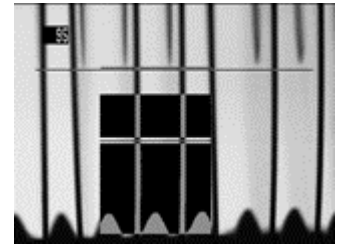**Figure 5   65MM**   **Figure 6   70MM**   **Figure 7   84MM**   **Figure 8 95MM**

Notice also that there are approximately 7 disks spanned by the long upper line
in these figures. If this is not the case for you, you should recheck the
camera position and also check to see that you have a 75MM lens.

Adjusting The Yaw Of The Camera

You need to adjust yaw if the height of the rib on the left end of the screen is not the same as on the right end.

Yaw can be adjusted by rotating the camera around Z-axis when the screw on the Z-axis is loosened, and you may use a line form the OPTION menu as a horizontal line to monitor the adjustment.

1. Place a 95MM cassette on the track.

2. Turn the dial on Eyebot to OPTION, select LINES, press YES several times to select an unused disk size as shown in Figure 9, press UP to move the long line down to the top of the ribs. You are going to use this line as a level site.

3. Rotate the camera until ribs at the two ends of the Rib Detection Window have the same height.

4. Reset the line to 0 by pressing the button DOWN then turn the dial back to TEST.
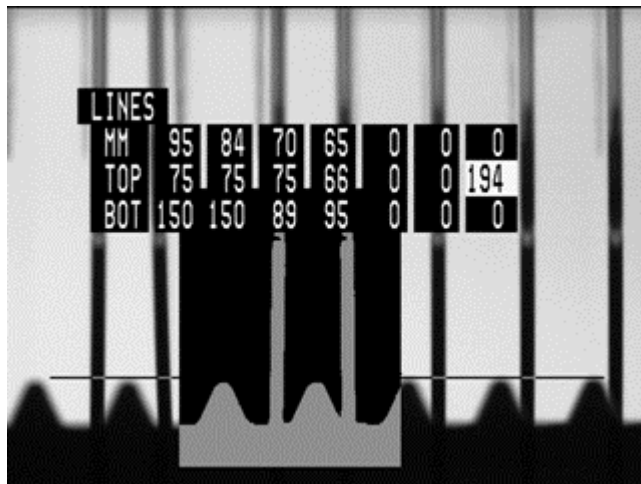

Figure 9 Using a line to test Yaw

The procedure above give a certain degree of accuracy, however, there is a more precise procedure. If the yaw is truly zero, then the height of the ribs will not be affected if the camera is pointed up or down the track. For highest accuracy, we recommend that you rotate the camera around it's mounting hole axis to double check if the height of the ribs remains constant. To do this, place a cassette directly under the camera. Loosen the camera's mounting screw and pivot the camera so it is imaging one far side of the cassette. Tighten the mounting screw. Use a line again to mark the height of the ribs on the monitor. Now loosen the mounting screw and pivot the camera toward the other side of the cassette. Tighten the screw again. The ribs should be at the exact height as previously marked with the tape. If this is not the case you need to re-adjust your mounting brackets. If the ribs are still at the same height, you can move the camera back to its looking-straight-down position.

Adjusting The Pitch Of The Camera

The camera must be pointed straight down rather than looking up or down the track. This is the pitch adjustment. The pitch of the camera is its rotation around its mounting hole.

For pitch adjustment we use a cassette with two or three disks inserted into each slot so that the disks are tight and not flopping from side to side as shown in Figure 10.
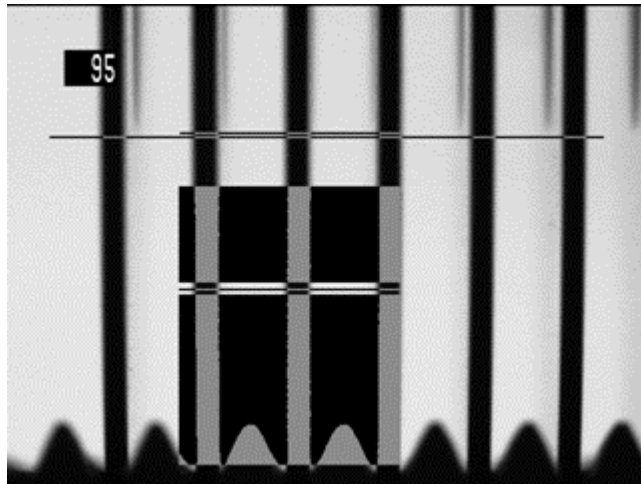

Figure 10   Adjusting the Pitch

Place the cassette on the track and the center slot directly under the camera. When the double disk is exactly in the center of the camera view, the dark silhouette should be clear and have no shadow on either sides. When the disks are off center, there are shadows because the camera can see the sides. The images have shadows from the holes of the disks. When the disks are on the right, the shadows are on the left, and vice versa.

Figure 10 shows a zero pitch image where the center disk gives a clear silhouette and other disks show symmetric shadows on the side. All of these disks are double disks, so they would not flop around while the image was taken.

If you see asymmetric shadows, loosen the mounting screw and pivot the camera slightly. The center slot will no longer remain in the center of the monitor and will have to be adjusted as well. Keep experimenting until you are confident that the camera is looking straight down.

Focusing the Camera

The glass 65MM disks are the most difficult to image, so we suggest focusing on these. Open the camera iris as much as the camera and monitor will allow without causing a white out effect to allow the most sensitive focus adjustment to be made. You want to focus on the tops of the disks, the ribs will remain a bit blurry. That's OK.

Adjusting the Iris

Set the iris (aperture) of the camera to f4 or f5.6 to test your inspection system and chose the one with best results, since different lighting may need different iris settings.

Camera Switches

The Mintron OS-60D has dip switches that should be set with 1, 6 and 8 switches up and 2, 3, 4, 5, and 7 switches down.

Fine Camera Adjustments

The fine camera mount allows precision
adjustment of the camera position. The
images below indicate the video effect of
adjusting the A and C dials. The exemplar
images are for a 95MM cassette. The B dial
affects both yaw and roll and should not be
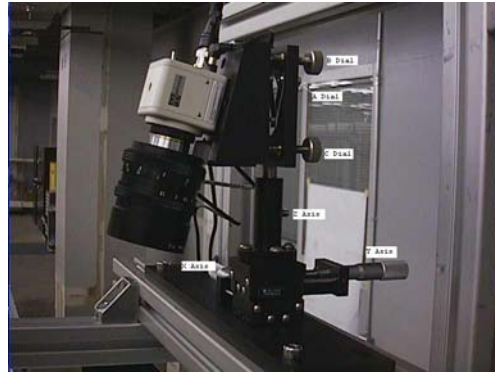used for fine adjustment.

Figure 11   Fine Camera Mount
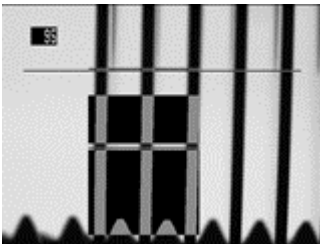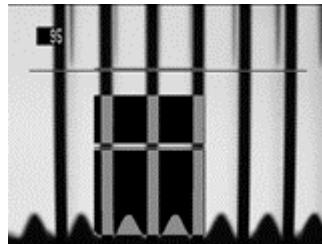

Fig 12 Adjusting Dial A clockwise

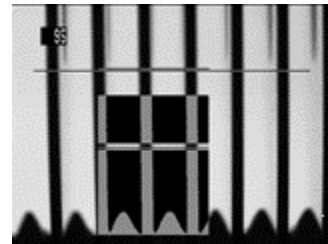**Fig 13 Exemplar Image**

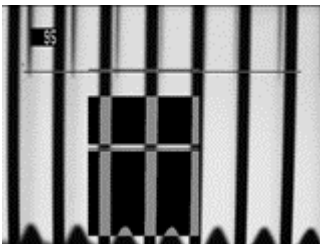**Fig 14 Adjusting Dial A
counterclockwise**
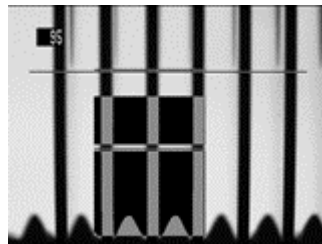

Fig 15 Adjusting Dial C clockwise
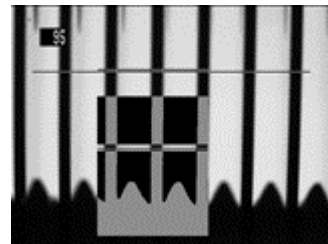

Figure 16 Exemplar Image

**Fig 17 Adjusting Dial C
counterclockwise**

SETTING THE PARAMETERS

The dial setting OPTION on the Eyebot allows you to adjust the Eyebot for different disk sizes and the trigger points for the inspection alarm. You will be doing roughly a three step setup process, 1) setting up trip points so that Eyebot can determine what disk size it is using, 2) setting the position of the data collecting lines for each disk size, 3) adjusting the alarm points for cross disks.

Main Menu

The first menu when dialing into OPTION will be the MAIN MENU shown below. The first line indicates the software date. No internal clock is used and HD2 Eyebot is Y2K compliant. One navigates through the options with the UP and DOWN buttons. When you want to select something press YES. When you are done press NO.

```
HD2 EYEBOT APR 2 2001
 TRIP
 LINES
 CROSS
 VIDEO
 OUTPUT
```

TRIP

After selecting TRIP, for example, you will see this menu:

```
 TRIP
  MM  95  84  74  65  0  0  0
  TP  90  30  15   2  0  0  0
```

The upper line is the diameter of the disks in millimeters. Three extra 0 sizes are available for future applications and can be adjusted at any time. Press YES to move to the highlight to a new size. UP/DOWN changes to these size definitions will be carried forward to the LINES and CROSS menu options.

The disk diameter size is selected by how low the ribs appear in the image. The lower the ribs indicates a larger diameter. As the video image is scanned from top to bottom, a counter starts counting from the top of the Rib Detection Window and continues on until the first rib is detected. The higher this value, called Rib Depth, the lower the rib is detected in the image.

The TP setting or Trip Point indicates when the next larger disk diameter is selected. If for example, the Rib Depth is 85, an 84MM size is selected because 85 is larger than 30, the 84MM Trip Point, but not larger than 90, the 90MM Trip Point.

Switching the Eyebot to RUN or TEST you can read the current Rib Depth by pressing the YES button. The current Rib Depth is the second reported number in the DEBUG line.

It would be a good exercise to fill out the chart below before deciding on the appropriate Trip Points.

SIZE	95MM	84MM	74MM	65MM
MAXIMUM				
MINIMUM				

Put the various disk sizes on the track and wiggle the cassettes so that you can determine what range of Rib Depths will be expected. Push the cassettes against the rails.

LINES

The next step is to place the data collecting lines on the various sized disks. Turn the dial again to OPTION and select LINES. This menu will appear

```
 LINES
  MM  95  84  74  65  0  0  0
  TOP 75  75  75  75  0  0  0
  BOT 150 150 150 150 0  0  0
```

The MM line indicates the disk diameters just like the previous TRIP menu. You will want to set the line positions so that they are farthest apart with two considerations. First, you don't want to put the lines where the ribs or where the shadows of the disk holes will interfere with the imaging of the disk thicknesses. Second, you will want to put the lines away from any internal reflections generated from glass disks.

CROSS

After the lines are set, and only after the lines are set, you can adjust the CROSS triggers. If you move any line, you will need to go back and readjust the CROSS triggers.

Turn the dial to OPTION and select CROSS. You will see this menu

```
CROSS
  MM  95  84  74  65  0  0  0
  RX  8   8   5   2   0  0  0
  LX  8   8   5   2   0  0  0
```

These are the triggers for Right Cross RX and Left Cross LX. These numbers are generally much smaller than LINES or TRIP. They indicate how many pixels a disk must be leaning, as measured on the lines you just positioned, in order to get

an alarm trigger. You will most likely have smaller cross triggers for the 65MM
disk size because the data lines will have to be closer together.

Use the UP and DOWN buttons to select the trigger you want, then use the YES
button to move across to the disk size you want, and then adjust the trigger
with the UP and DOWN buttons. Press NO twice to return to the Main Menu.

The need for two triggers, Right and Left Cross, needs explanation. Due to
parallax, camera mounting inaccuracies, and the asymmetry of the software
algorithms, which measures all slants from the left hand side of the active data
lines, it will be nearly impossible for a right crossed disk to register the
same number of pixels discrepancy then a similarly position left crossed disk.
Early on in the development of the software for Eyebot HD2, it became clear to
have a separate trigger points for disks leaning to the right and another
separate trigger point for disks leaning to the left.

Right Cross means that the disk, as viewed by the camera, is leaning with the
top falling to the right. Left cross means the disk is leaning to the left.

VIDEO

The settings under VIDEO should perhaps not be tampered with. The default
settings should be OK. However, if you turn the dial to OPTION and select VIDEO
here is what you will see.

```
VIDEO
 LOWER THRESHOLD 100
 UPPER THRESHOLD 130
 TOP BOX 102
 BOT BOX 230
```

The first two settings indicate the video thresholds of the image processing.
There should be a little distance between the two representing, a video dead
band. We have not had opportunity to fully explore the possibility of using
different threshold values for the IBM application. Sufficient to say that these
settings are the most tested values. Other lighting conditions may require
adjustments. The UPPER THRESHOLD should be adjusted from a high value down to
where the image looks crisp. Likewise, the LOWER THRESHOLD should be adjusted
from a low value up to where the image looks crisp. They are measured in image
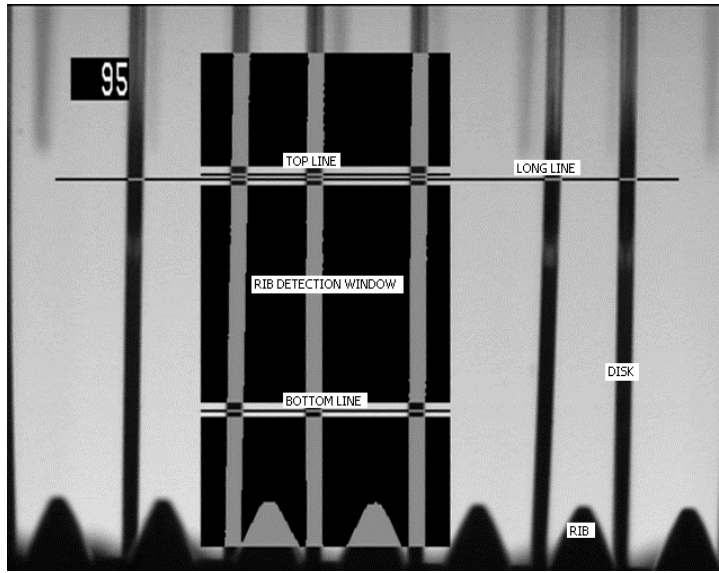gray levels.

Figure 18 Active Data Collection Areas

TOP BOX and BOT BOX adjust the position of the Rib Detection Window shown in Figure 18. You want to make sure that the Rib Detection Window covers the tops of the ribs. IBM San Jose and IBM Dublin have installed special rails to narrow the track width to further confine the position of the ribs as viewed by the cameras.

Do not adjust these positions too much. The default settings should get you pretty much there. It is better to try to adjust the camera mounting.

OUTPUT

Turn the dial to OPTION and select OUTPUT.

```
OUTPUT
 LATCH OFF
 MAX DWELL 40
 MIN DWELL 30
 DISPLAY REVERSE OFF
```

LATCH ON will cause the Eyebot alarm to latch on until it is cleared by either dialing out of RUN, pressing YES, or closing the Alarm Reset pin on the DB25 connector.

MAX DWELL and MIN DWELL, when LATCH is OFF, indicate how the minimum amount of time and the maximum amount of time the alarm will sound when the alarm goes off. The time is measured in video clock fields or 1/60 of a second. MAX DWELL 60, for example, would beep for 1 second.

DISPLAY REVERSE flips the monitor error reports. Since the viewing angles of two Eyebot cameras on a two-lane conveyor system cross each other, it will be customary to have one Eyebot with DISPLAY REVERSE ON and one with DISPLAY REVERSE OFF.

THE DEBUG LINE

The Debug Line is made visible by rotating the dial to TEST or RUN and then pressing the YES button once. Eight numbers are indicated when a cassette is moving through the camera view as shown in Figure 19.

Figure 19 The Debug Line

1) RIB STATUS is perhaps the most important indicator of the overall health of the video imaging. This is the number of ribs visible in the Rib Detection Window.

It should read 0 when no cassette is present, go to 1 when the cassette begins to move into view, and stay a steady 2 while the ribs traverse through the rib detection window.

A slight flicker with the 2 during traverse can be disastrous, because the Eyebot then believes, for a short while, that it is looking at end disks, when it is not. This may cause inaccurate rib counting.

2) RIB DEPTH indicates the vertical height the ribs in the image and is therefore and indication of the cassette disk size. The higher the number, the lower the ribs are in the image. Use TP Trip Point to adjust where certain sizes are chosen.

3) DISK TYPE is the diameter of the disk seen in Millimeters.

4) RIB LEFT is the horizontal position of the first rib detected from the left.

5) SIZE is the thickness of the disk measured in pixels. Doubled disks are alarms occur when the thickness measured is more than 50% higher than the average disk size.

6) LEFT SLANT is the slant to the left (as if the disk were falling to the left) of the current disk measured in pixels. LEFT SLANT will indicate zero if the disk is leaning to the right. Look at LEFT SLANT to get an idea where to set CROSS|LX.

7) RIGHT SLANT is the slant to the right of the current disk measured in pixels. Use this to set CROSS|RX.

8) RIB COUNT should count from 1 to 24 for manufacturing cassettes, and from 1 to 26 for shipping cassettes.

RUNNING THE EYEBOT

When you first turn EYEBOT on you will see a message:

  SIGHTECH OSD V1

This indicates the On Screen Display firmware presently used in your Eyebot.

Turning the dial will get rid of this message and you should see at the top of the monitor a test result Report Line:

  AUTO [|||||||||||||||||||||||||] 1

Each straight line indicates a good and filled slot. Dial TEST and let your first cassette go by. You may get a result that looks like this:

  95MM [|V|||||||X||||D|||||M||||] 25

95MM is the size of the disks. A V indicates two cassettes crammed into a single slot on the bottom or view side of the cassette, as shown in Figure 21. An X indicates slanted disks, shown in Figure 22 and Figure 23. This would probably mean that on the other side of the cassette, out of the view of the Eyebot, there is a slot with two disks crammed into it. In either case, V or X, you have a crossed disked situation. A D indicates a doubled disked, as shown in Figure 20. An M indicates a missing disk.
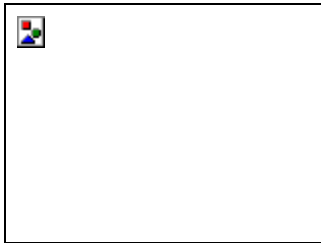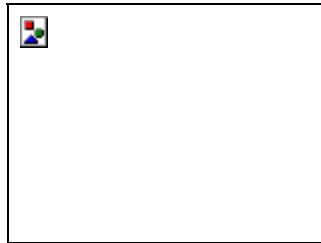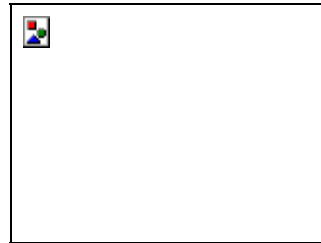

| **Figure 20 D Double** | **Figure 21 V Jam** | **Figure 22 X Left Cross** | **Figure 23 X Right Cross** |

The last number, in the REPORT LINE, is a number based on the number of ribs that the EYEBOT has seen. For manufacturing cassettes the Eyebot will see 24 ribs. There is an extra disk at the end and so Eyebot will report 25 for a good rack of disks. Sometimes, when the ribs can be so jammed with extra disks, or so crossed, Eyebot will miscount. We have found this particularly so for 65MM cassettes. If Eyebot miscounts, it will generate an error alarm.

Eyebot inspects in TEST or RUN. The difference is that in RUN, the output solid-state relays and beeping sound are active. ERASE, LEARN, VIEW, and IGNORE are not presently used by the HD2 software.

TROUBLESHOOTING

No Video

Check video cables making sure that the monitor and camera are not reversed. The camera may not have power. Try connecting the camera directly to the monitor.

Video Fuzzy

Make sure that the switch on the back of the monitor is set to 75 ohms.

Video Flicker

Adjust the camera iris to f5.6 or f4.

Lots of False Crosses

Check to make sure that the hole shadows aside disk silhouette in the image do not cross the Data Collecting Lines. Check to see if the CROSS|RX and CROSS|LX have been tampered.

Miscount Disks Errors

Make sure that the ribs can be seen no matter where the cassettes may track through the camera view.

SYSTEM OUTPUTS

RS232 Output

The same information sent to the monitor Report Line is also sent to the serial
port. Communication is 19.2K baud N81. Additionally, more setup information can
be obtained by sending the letter q to the Eyebot in which case you will get
information after each cassette that looks like this:

```
q

  0  0  3  3  3  0  3  3  2  3  3  3  3  3  3  2  2  2  0  3  2  0  2  3  2

  0  0  0  0  0  2  0  0  0  0  0  0  0  0  0  0  0  0  0  1  0  0  2  0  0  0

  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0

  10 9 10 10 10 10 10 10 10 10 10 10  9 10 10 22 10 10 10 10 10  9 10 10 10

  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0

  4  4  3  4  4  3  4  3  4  4  3  4  4  3  4  4  3  4  4  4  3  4  4  3  4

95MM  ..............D.........  25 FAIL
```

Each line has 25 entries corresponding to the disks in the cassette. The first
line is Slant Right in pixels. The second line is Slant Left in pixels.

It is possible to have a disk register both slant right and slant left because
the each disk is inspected more than once. The maximum slants encountered are
reported.

The third line indicates the number of times the Eyebot saw a disk that was a V
defect, that is, two disks crammed into one slot.

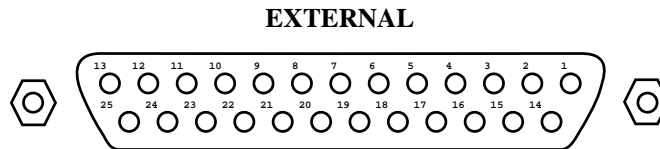The forth line is the maximum disk thickness encountered.

The fifth line is the number of times Eyebot saw a missing disk.

The sixth line is the number of times the Eyebot saw a present disk.

The last line is the same as the Report Line.

External (DB-25) Connector

This connector is located on the rear of Eyebot. Eyebot has two optically isolated relays that provide Decision and vertical sync (video) outputs and part-ready strobe input. This connector allows Eyebot to more directly interface with part lighting, movement, and processing.

EXTERNAL

DB25 Connector Pins

Pin #	Name	Description
1	Case Ground	Use to ground Eyebot.
2	Reserved	
3	Reserved	
4	Reserved	
5	Reserved	
6	Power +	Positive terminal unregulated 12 to 24V power @500ma
7	Power –	Negative terminal unregulated 12 to 24V power @500ma
8	Failsafe Sensor	Shorting this to pin 11 will cause an alarm in 10 seconds if the Eyebot does not see a cassette.
9	Reserved	
10	Alarm Reset	A low resets an alarm condition. Shorting to Isolated Input Ground (pin 11) pulls this pin LOW, and resets Eyebot.
11	Isolated Input Ground –	Isolated Ground for Isolated Input +
12	Output #2	Relay Output #2 – switches 60V max, 3 Amp max, AC/DC. Normally closed.
13	Output #1	Relay Output #1 – switches 60V max, 3 Amp max, AC/DC. Normally open.
14	Reserved	
15	Reserved	
16	Reserved	
17	Reserved	
18	Reserved	
19	Reserved	
20	Reserved	
21	Reserved	
22	Reserved	
23	Reserved	
24	RELAY2 GND	Relay Output #2 Ground
25	RELAY1 GND	Relay Output #1 Ground

Serial Connector

This connector is located on the rear of Eyebot. It is an isolated DB-9 RS-232, DTE female connector designed to plug directly to an IBM PC compatible serial port. Only RxD and TxD are active. The default transmit rate is 19200 Baud N81.

Serial (DB-9) Pins

Pin #	Name	Description
1	No Connection	
2	RxD	Serial Output from Eyebot to Host (PC, etc.) RS-232 +/- 12V signal
3	TxD	Serial Input to Eyebot from Host (PC, etc.) RS-232 +/- 12V signal
4	No Connection	
5	Serial Ground	Serial Signal Ground
6	No Connection	
7	No Connection	
8	No Connection	
9	No Connection	