



CROSS-DIRECTION CALIPER CONTROL
OPERATOR GUIDE



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Preface

The Foxboro Cross-Direction Caliper Control package enhances the capabilities of your paper machine. It regulates the caliper of the sheet at the calender stack in order to maintain even caliper across the width of the sheet. The result is high-quality paper produced at a rapid rate.

Audience

People who monitor and operate paper machines under The Foxboro Company I/A Series distributed control system should be familiar with the contents of this guide.

Related Documents

Cross-Direction Caliper Control Maintenance Guide (ISD0021TE).

Conventions

This document uses the following convention:

Items you select and entries you type appear in *this* typeface.

Cross-Direction Caliper Operation and Control

Cross-Direction Caliper Control regulates the application of heat to narrow zones across the calender stack. Heat causes the roll to expand slightly, thus increasing the roll pressure and reducing the caliper of the sheet in that zone. Removing heat has the opposite effect. Optimization routines minimize the overall application of heat, consistent with maintaining the proper caliper control.

The scanner at the dry end of the machine takes caliper readings across the width of the sheet. After each scan, the control loop constructs a new caliper profile. At the end of each control cycle, the controller calculates a new group of setpoints and writes them to the caliper actuators. Each control cycle is typically six to eight scans. Because each scan is about thirty seconds long, one control cycle lasts about three to four minutes.

Operator Display

The operator display contains two profiles, several display functions, and nine task buttons with quarter-screen overlays (Figure 1). The upper half displays an error profile that summarizes the scanner caliper readings across the width of the sheet. The lower half displays the status and output of each actuator in the steambox. The task buttons at the bottom of the display and their overlays enable you to:

- Put Cross-Direction Caliper in automatic or manual control.
- Preset all actuators to a value between 0% and 100%.
- Set the output value for individual zones.
- Put individual zones in automatic or manual control.
- Enter a bias value for individual zones.
- Change the output value for all the actuators by the same amount.
- Check which fault conditions have suspended automatic control.

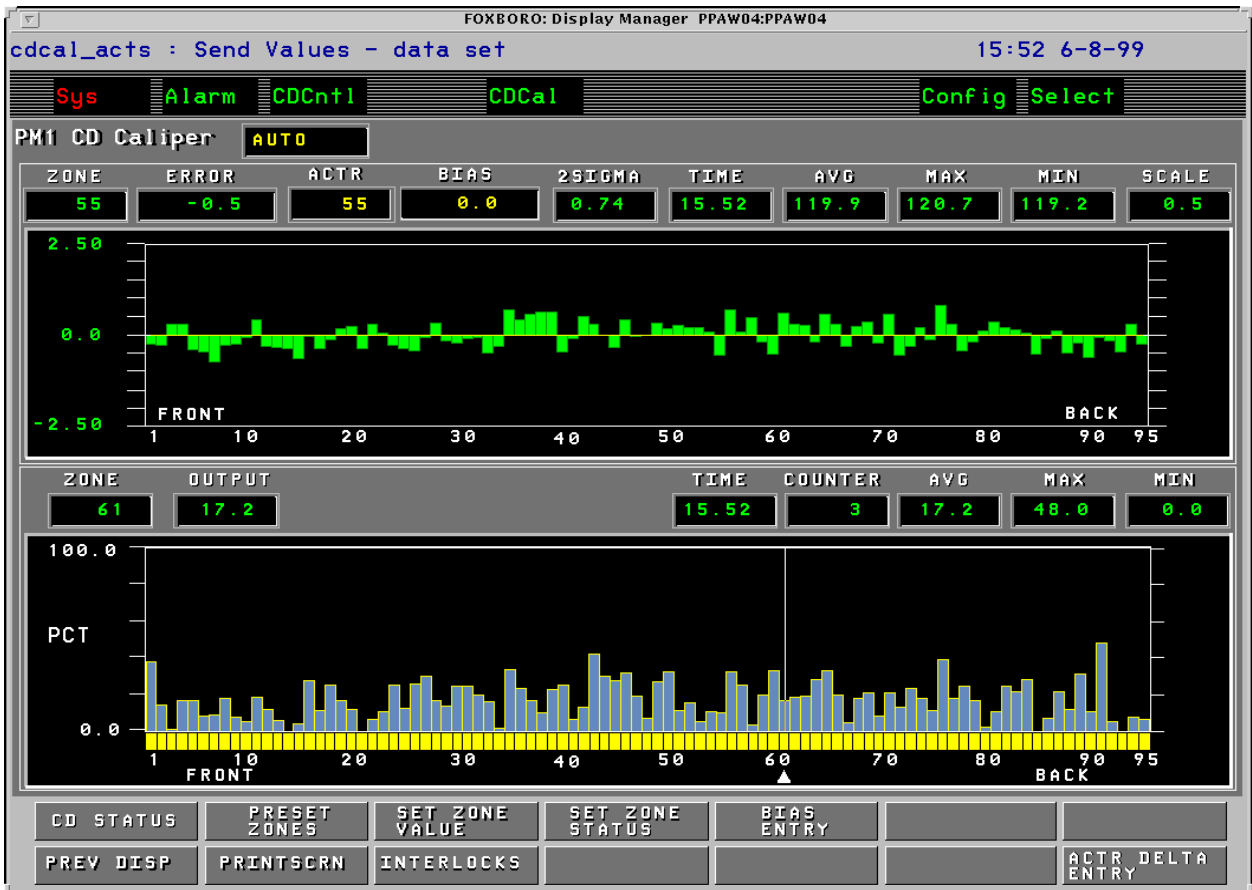


Figure 1 Error and Actuator Profiles

Control Functions

Cross-Direction Caliper Control removes caliper streaks to attain a level caliper profile across the width of the sheet. The status box below the top menu bar contains one of three indications:

- AUTO (yellow): Only the control loop updates the setpoints of the actuators.
- MANUAL (green): Only the operator changes the setpoints of the actuators.
- SUSPEND (blinking red): A fault condition, such as a sheet break, has suspended supervisory control. After the operator clears the fault, automatic control resumes.

Error Profile

The upper half of the display contains an error profile that shows the caliper value of the paper in each zone (Figure 2). The vertical bars in the error profile indicate how much the caliper of the paper, in a particular zone, deviates from the average caliper of the paper across all zones. The higher the green bar rises above the zero line, the higher the caliper in that zone. The lower the bar drops below the zero line, the lower the caliper in that zone.

The display numbers the zones from front to back. In Figure 1, the left side of the scale represents the edge of the sheet at the front of the paper machine (Zone 1); the right side of the scale represents the edge of the sheet at the back of the paper machine (Zone 95).

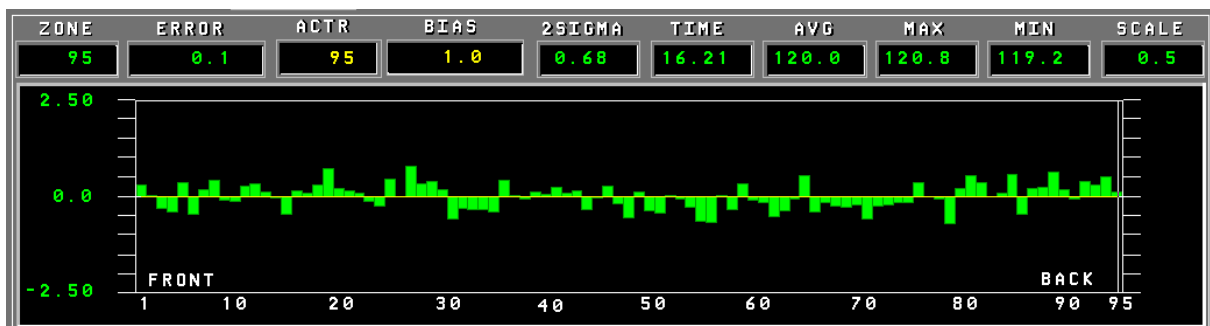


Figure 2 Error Profile

The small windows above the error profile contain the following information:

Zone	Displays currently selected zone for the caliper profile.
Error	Shows the amount by which the caliper in a selected zone differs from the average caliper of the paper measured across all the zones.
Actuator	Displays the number of the currently selected actuator.
Bias	Shows the bias for the currently selected zone.
2sigma	Provides a measure of variability in the caliper profile. If most caliper readings differ very little from the average caliper of the paper, 2sigma is small. If most caliper readings differ a great deal from the average caliper of the paper, 2sigma is large (See Variability in the Error Profile on page 18).
Time	Indicates when the scanner and controller last updated the error profile with a new set of caliper readings. Updates take place approximately every thirty seconds.
Avg	Shows the average caliper of the paper, measured across all the zones in the sheet.
Max	Displays the reading for the zone that shows the highest caliper value.
Min	Displays the reading for the zone that shows the lowest caliper value.
Scale	Indicates the length of the vertical axis in the error profile. An entry of 0.3 indicates that the scale varies from - 3.0 mils at the bottom of the axis to + 3.0 mils at the top.

Actuator Profile

The lower half of the screen contains the actuator profile (Figure 3). It shows the status and the output value of each of the actuators. The profile in Figure 3 is configured for a system with 95 actuators. The output value for each actuator ranges from 0% to 100%. An output value of 0% indicates no heat is being applied; 100% indicates the maximum amount of heat is being applied. The profile shows the output value of each actuator as a filled bar. Yellow bars designate actuators under automatic control; green bars designate actuators under manual control.

A pointer appears underneath the actuator profile. It indicates the actuator or zone selected.

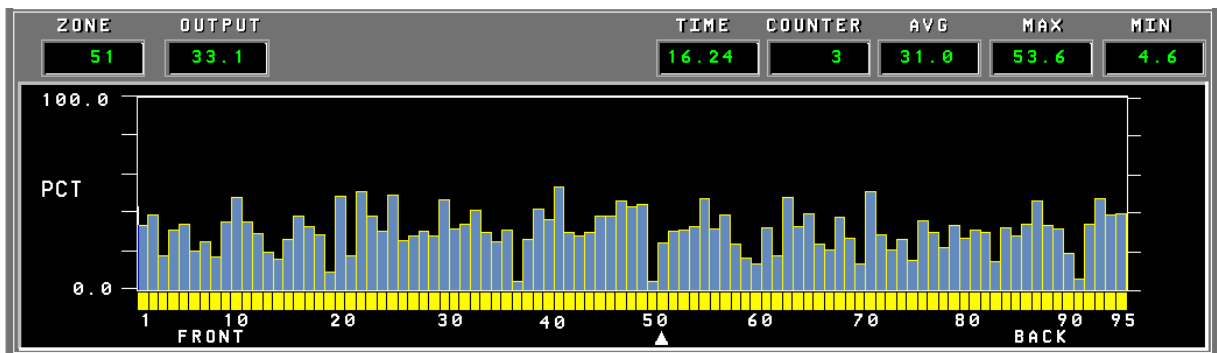


Figure 3 Actuator Profile

The small windows above the actuator profile contain the following information:

Zone	Displays the currently selected actuator.
Output	Shows the output for the selected actuator.
Time	Indicates when the controller last updated the setpoints of the actuators. When the actuators are under automatic control, updates take place approximately every three to four minutes.
Counter	Shows the number of scans left in the current control cycle. If the number of scans per control cycle is eight, this indicator counts down from eight to zero.
Avg	Displays the average output of the actuators measured across all the actuators.
Max	Indicates the output value for the actuator with the highest output.
Min	Indicates the output value for the actuator with the lowest output.

Procedures and Examples

The operator display allows you to perform several tasks directly from the main screen (Figure 4).

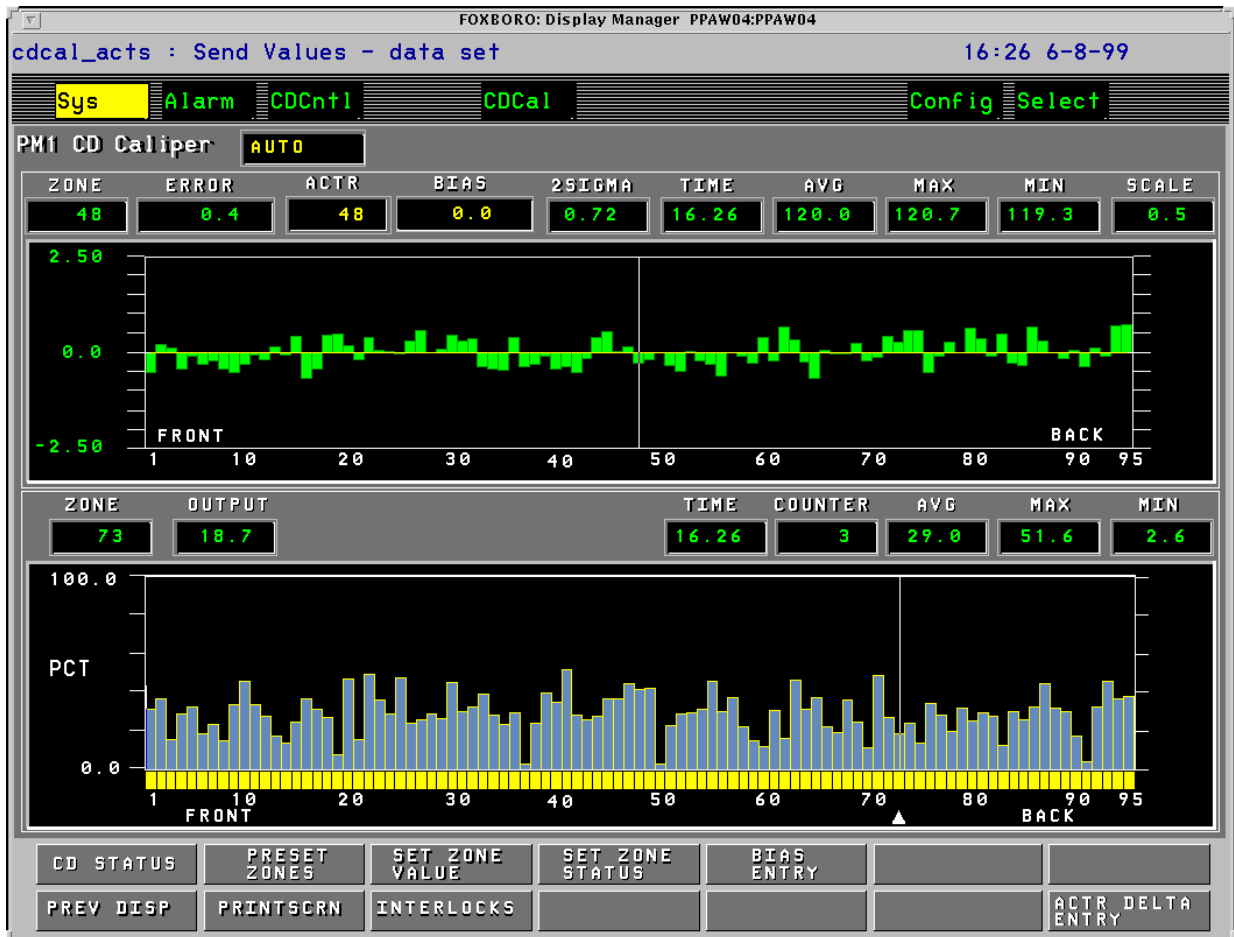


Figure 4 Operator Display

To select a zone in the upper half of the display:

- Click above the desired zone number in the black area of the error profile. The vertical cursor moves to that zone and the appropriate data windows display information about the zone.

To select an actuator in the lower half of the display:

- Click the small Actuator Number window above the steambox profile and enter a new number.

To change the vertical scale of the error profile:

- Click the box labeled **SCALE** in the upper right-hand corner of the error profile, type the new number (accurate to the nearest tenth) and press Enter.

To print a copy of the current screen on your local printer:

- Click **PRINTSCRN** at the bottom of the display.

To bring up the display that appeared on the screen prior to the current display:

- Click **PREV DISP** at the bottom of the screen.

The actuators normally operate under automatic control, but from time to time you must intervene to initiate some action or make some adjustment. Seven of the task buttons at the bottom of the screen allow you to interact with the actuators via quarter-screen overlays. To bring up the overlay you need for a particular task, click the appropriate task button at the bottom of the display. Table 1 contains a list of these task buttons, their associated overlays, task descriptions, and typical settings.

Table 1 *Operator Display: Task Buttons*

Task Button	Overlay	Task Description	Typical Setting
CD Status	Cross-Direction Caliper Status Change	Puts actuators in automatic or manual control	Auto or Manual
Preset Zones	Actuator Preset Mode	Presets all zones to the same output value	0 to 100% 30%, typical
Set Zone Value	Actuator Single Zone Value Mode	Sets the output value for a specified zone	0 to 100%
Set Zone Status	Actuator Zone Status Change	Puts a specified zone in automatic or manual control	Auto or Manual
Bias Entry	Caliper Zone Bias Mode	Increases or decreases the caliper in a specified zone	0 to ± 2 mils
ACTR Delta Entry	Actuator Delta Mode	Increases or decreases the output value in all zones by the same amount	0 to $\pm 50\%$
Interlocks	Actuator Interlocks	Determines what fault condition has suspended automatic control	Green or White

Cross-Direction Status

To switch Cross-Direction Caliper from automatic to manual control:

1. Click **CD STATUS** at the bottom of the operator display.
The Cross-Direction Caliper Status Change overlay appears (Figure 5).

2. Click **PRESS TO TRANSFER CROSS-DIRECTION CALIPER TO MANUAL.**

All of the zone indicator bars in the actuator profile change from yellow to green.

To return the system to supervisory control:

1. Click **CD STATUS** at the bottom of the operator display.
2. Click **PRESS TO TRANSFER CROSS-DIRECTION CALIPER TO AUTO.**

The zone indicator bars change from green to yellow.

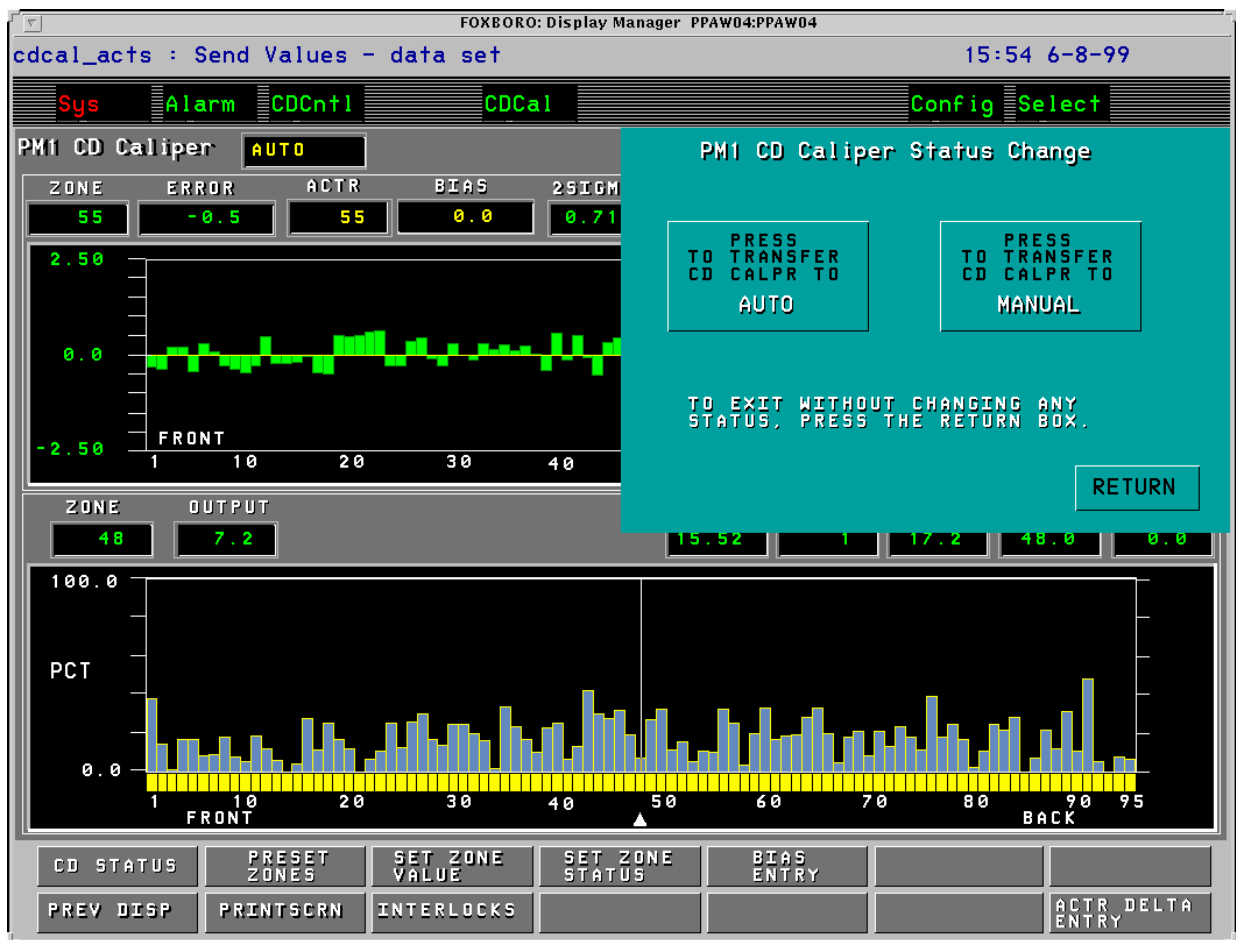


Figure 5 Cross-Direction Caliper Status Change Overlay

Preset Zones

To set the output value for all the actuators to the same figure:

1. Click **PRESET ZONES** at the bottom of the operator display.

The Cross-Direction Caliper Preset Mode overlay appears (Figure 6).

2. Click the **PRESET VALUE** box to change the current value.

The box changes to blue with a yellow cursor.

3. Type the desired preset value (for example, 35%) and press Enter.

4. Click **PRESS TO CONFIRM PRESET TO THE PRESET VALUE AND PUT ALL ZONES IN MANUAL.**

The zone indicator bars adjust to the value you entered and change from yellow to green.

5. Click **RETURN** to close the overlay.

The zone indicator bars in the actuator profile change from yellow to green and adjust to show 35% output (Figure 7).

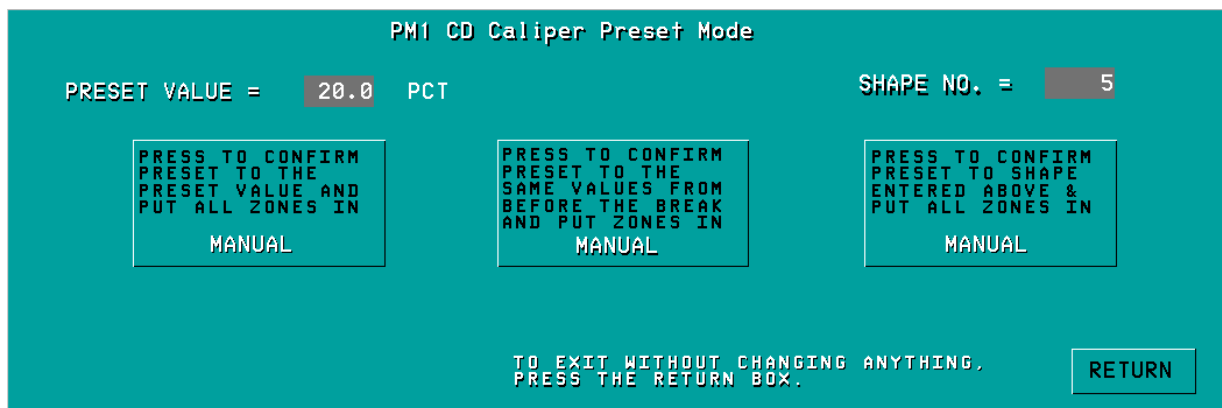


Figure 6 Cross-Direction Caliper Preset Mode Overlay

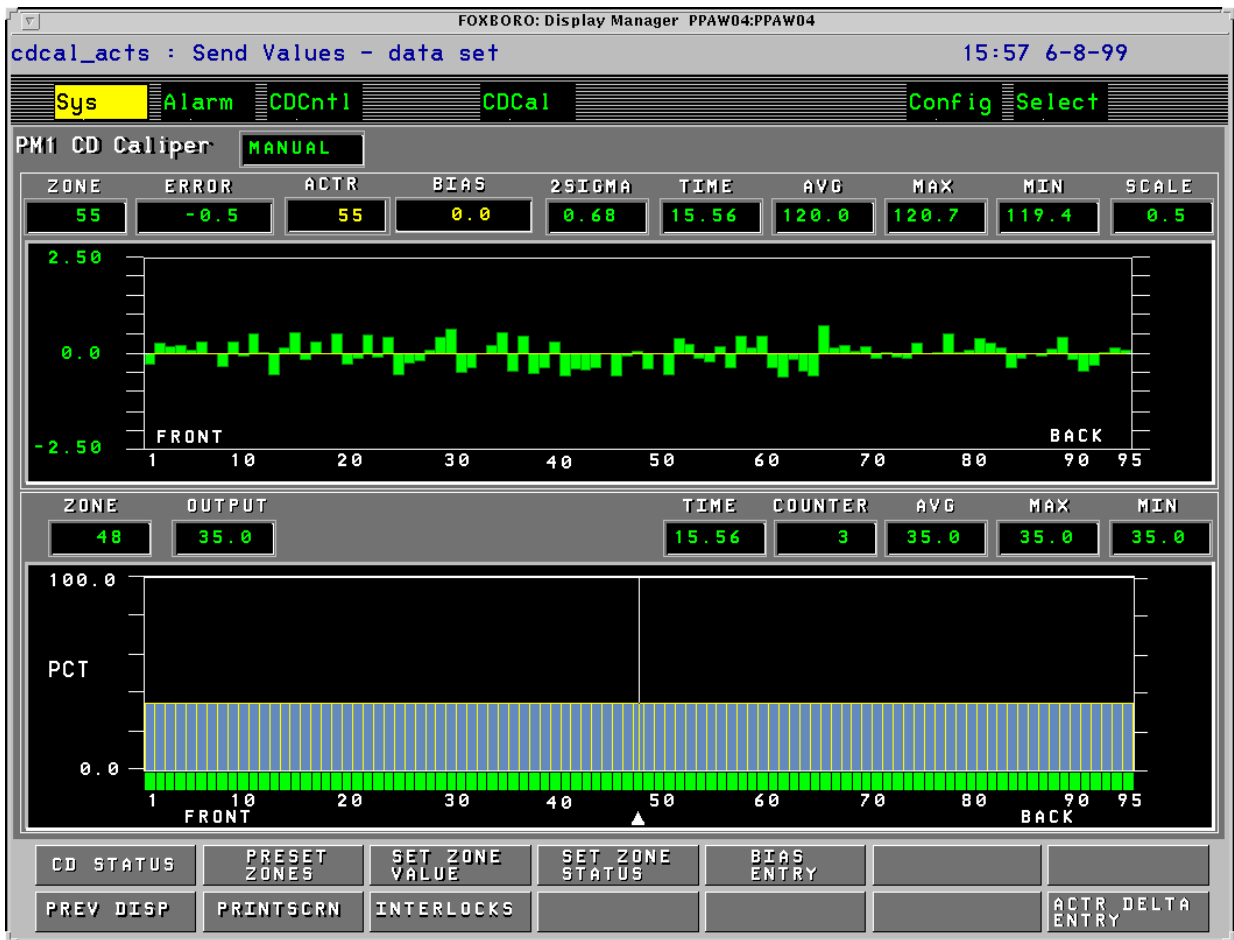


Figure 7 All Actuators at 35% Output

To preset the actuators to the values they had prior to a sheet break:

1. Click **PRESS TO CONFIRM PRESET TO THE SAME VALUES FROM BEFORE THE BREAK AND PUT ZONES IN MANUAL.**
2. Click **RETURN** to close the overlay.

To preset the actuators to one of five pre-configured shapes:

1. Click the **SHAPE NO.** box.
The box changes to blue with a yellow cursor.
2. Type the desired shape number (1 through 5) and press Enter.
3. Click **PRESS TO CONFIRM PRESET TO SHAPE ENTERED ABOVE & PUT ALL ZONES IN MANUAL.**
4. Click **RETURN** to close the overlay.

Set Zone Value

To set the output value for an individual zone:

1. Click **SET ZONE VALUE** at the bottom of the operator display.

The Cross-Direction Caliper Single Zone Value Mode overlay appears (Figure 8).

2. Click the **ZONE** box.

The box changes to blue with a yellow cursor.

3. Type the number of the zone whose output value you want to change. Press Enter.

4. Click the **ZONE VALUE** box.

The box changes to blue with a yellow cursor.

5. Type the desired output value for that zone and press Enter.

6. Click **PRESS TO CONFIRM ENTRY OF ZONE VALUE. ZONE WILL BE PLACED IN MANUAL.**

The height of the bar for that zone adjusts to indicate the output value you entered. The color of the bar changes from yellow to green if the zone was under automatic control when you changed its output value.

7. Click **RETURN** to close the overlay.

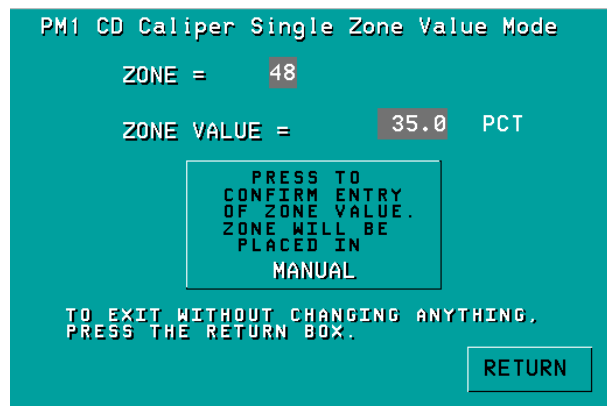


Figure 8 Cross-Direction Caliper Single Zone Value Mode Overlay

Set Zone Status

To change the control status of a zone from automatic to manual:

1. Click the zone you want to select in the upper half of the operator display.
The vertical cursor moves to that zone.
2. Click **SET ZONE STATUS** at the bottom of the operator display.
The Cross-Direction Caliper Zone Status Change overlay appears (Figure 9).
3. Click **PRESS TO PUT THIS ZONE IN MANUAL**.
The zone indicator bar in the actuator profile changes from yellow to green.
4. Click **RETURN** to close the overlay.

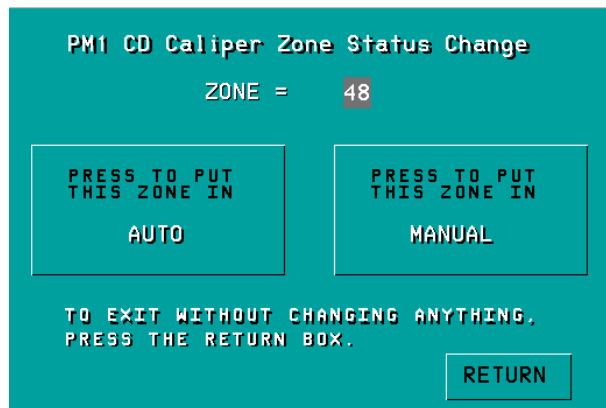



Figure 9 Cross-Direction Caliper Zone Status Change Overlay

Note  You cannot put an individual zone in Automatic if the Cross-Direction Caliper Supervisory control loop is not in Automatic. You can always put a zone in Manual.

Bias Entry

To increase or decrease the caliper in a particular zone, without taking that zone out of automatic control, click **BIAS ENTRY** at the bottom of the display. The controller reduces output in zones that you bias upward to make those sections thicker than the rest of the sheet. Conversely, the controller increases the output in zones that you bias downward to reduce the caliper in those sections of the sheet.

To change the bias entry for a zone:

1. Click **BIAS ENTRY** at the bottom of the operator display.

The Cross-Direction Caliper Zone Bias Mode overlay appears (Figure 10).

2. Click the **ZONE** box.

The box changes to blue with a yellow cursor.

3. Type the number of the zone whose bias you want to change and press Enter.

4. Click the **BIAS** box.

The box changes to blue with a yellow cursor.

5. Type the new value for bias in that zone. For negative values, type a minus sign and then the number. For fractional values, type a decimal point first and then the number. Press Enter.

6. Click **PRESS TO CONFIRM ZONE BIAS**.

The yellow line in the error profile moves up or down to indicate the new bias entry for that zone.

7. Click **RETURN** to close the overlay.

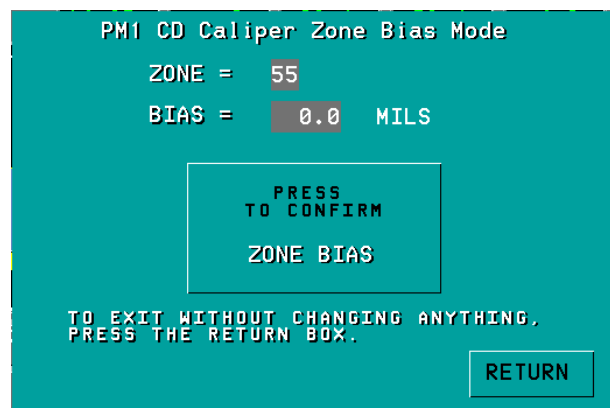


Figure 10 Cross-Direction Caliper Zone Bias Mode Overlay

To increase the caliper at the edges of the sheet without putting Zones 1 and 95 in manual control, bias these zones upward. For example, a bias of 1.0 in Zones 1 and 95 means that the target caliper for these zones is 1 mil higher than the average (Figure 11).

To increase the bias entry for the zones at the edge of the sheet:

1. Click **ZONE 1** in the error profile.
2. Click **BIAS ENTRY**.
3. Click the box that contains the current bias entry for that zone.
4. Type **1.0** and press Enter.
5. Click **PRESS TO CONFIRM ZONE BIAS**.
6. Click **ZONE 95** in the error profile.
7. Click the box that contains the current bias entry for that zone.
8. Type **1.0** and press Enter.
9. Click **PRESS TO CONFIRM ZONE BIAS**.
10. Click **RETURN**.

After a few moments, the yellow line across the middle of the error profile slopes upward at both ends to indicate the new bias for the zones at the edge of the sheet.

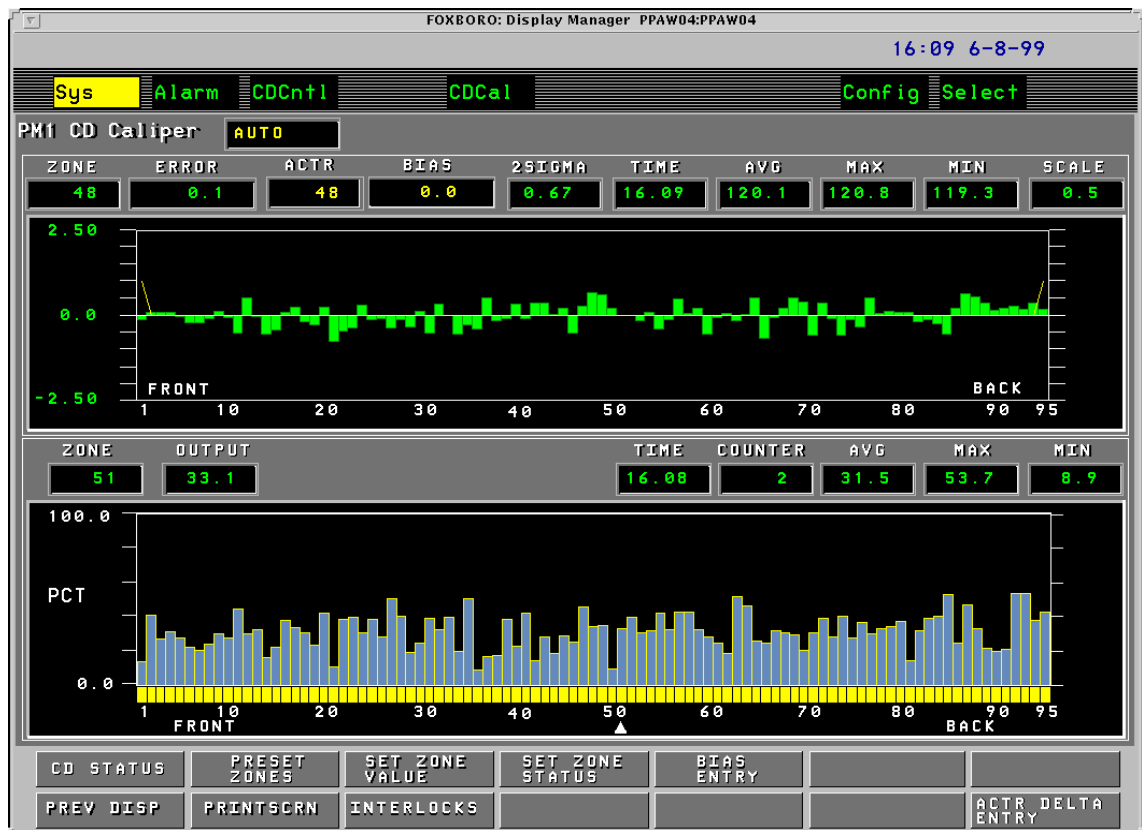


Figure 11 Bias Increased to 1.0 in Zones 1 and 95

Actuator Delta Entry

When you want to change the output value for all the actuators by the same amount, without changing the differential between adjacent zones, you must take the actuators out of automatic control and transmit a new delta value to the actuators manually.

To specify a delta entry for all of the actuators:

1. Click **ACTR DELTA ENTRY**.

The Cross-Direction Caliper Actuator Delta Mode overlay appears (Figure 12).

2. Click the **DELTA VALUE** box.

The box changes to blue with a yellow cursor.

3. Type the desired delta value. To decrease the output by the same delta value across all the actuators, type a minus sign and then the number.

4. Press Enter.

5. Click **PRESS TO CONFIRM ENTRY OF DELTA VALUE. ALL ZONES WILL BE PLACED IN MANUAL**.

The indicator bars change from yellow to green and increase or decrease by the specified amount.

6. Click **RETURN** to close the overlay.

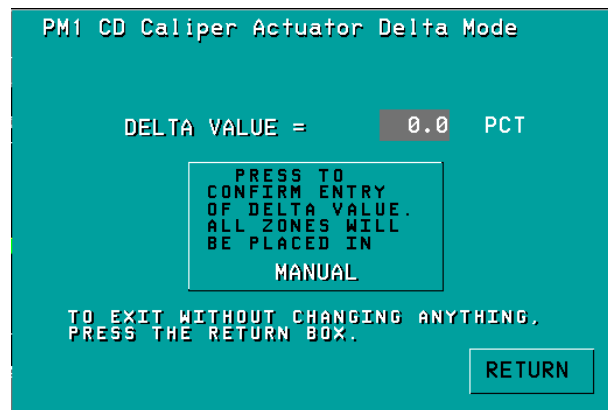


Figure 12 Cross-Direction Caliper Actuator Delta Mode Overlay

For example, to raise the output value for each actuator 10%:

1. Click **ACTR DELTA ENTRY**.
2. Click the **DELTA VALUE** box.
3. Type **10** and press Enter.
4. Click **PRESS TO CONFIRM...** in the center of the overlay.

All of the zone indicator bars in the actuator profile increase by the same amount and change from yellow to green (Figure 13).

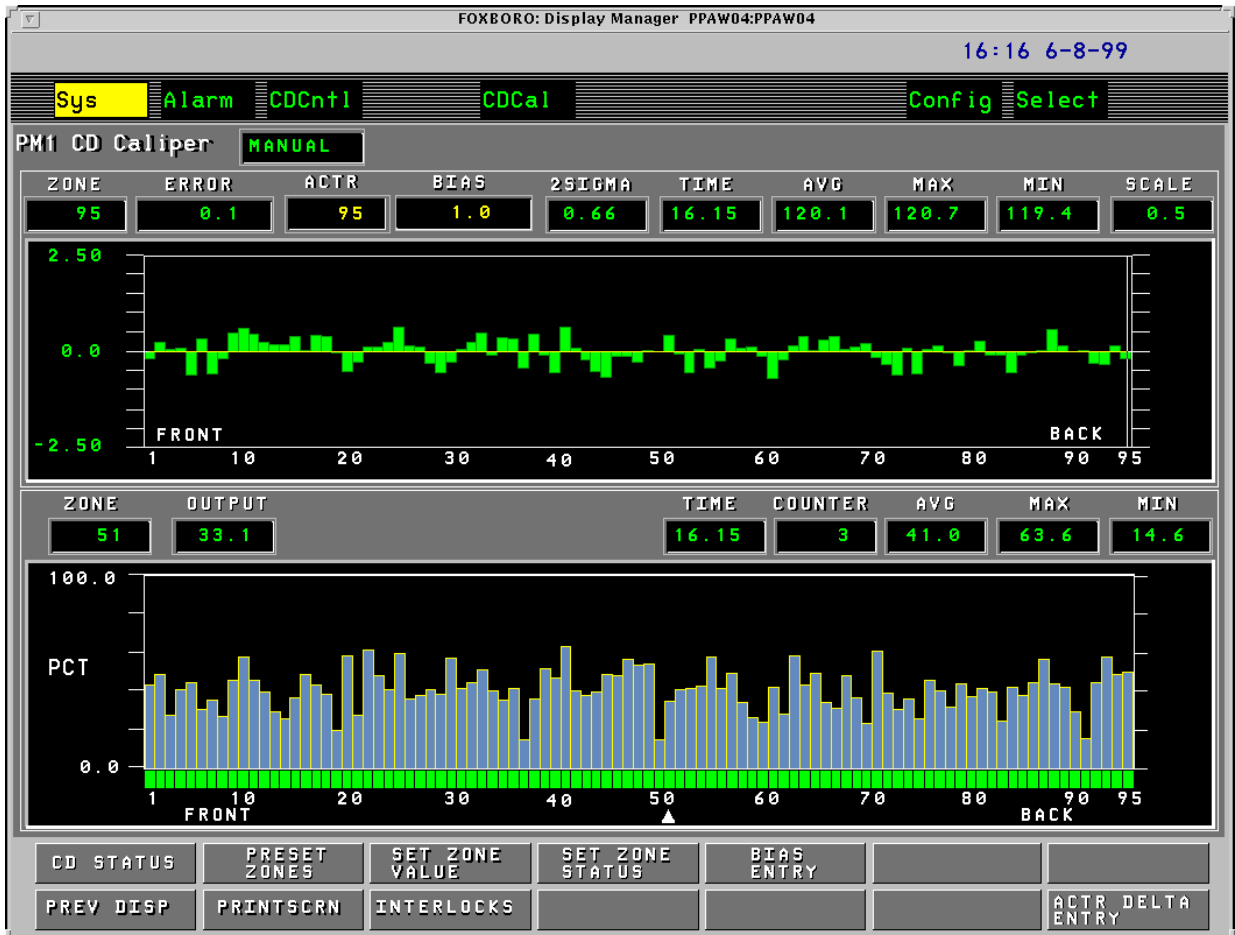


Figure 13 Actuator Output in All Zones Increased by 10%

Interlocks

Certain fault conditions suspend automatic control of the Cross-Direction Caliper actuators. The Cross-Direction Caliper Interlocks overlay lists these conditions and indicates which ones have tripped an interlock. If a problem of this sort occurs, the Cross-Direction Caliper status indicator above the error profile flashes SUSPEND in red.

To determine which fault condition has suspended automatic operation and to restore the actuators to supervisory control:

1. Click **INTERLOCKS** at the bottom of the operator display.

The Caliper Interlocks overlay appears (Figure 14).

2. Check the list in the overlay for fault conditions highlighted in white to identify the faults that have suspended automatic control.
3. Correct the fault conditions highlighted in white.

The system resumes supervisory control when all the interlocks are satisfied.

4. Click **RETURN** to close the overlay.

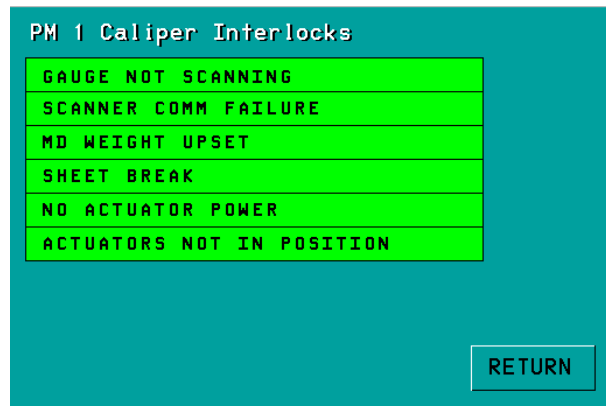


Figure 14 Cross-Direction Caliper Interlocks Overlay

Appendix: Error Profile Detail

How the Controller Constructs the Error Profile

The scanner takes caliper readings across the entire sheet just before it goes onto the reel. The controller calculates the average caliper content of the paper based on the profile it receives from the scanner. Then it subtracts this average from the caliper reading for each zone. The difference between the caliper reading in a zone and the average caliper across all the zones is the error for that zone.

- The error is positive if the caliper reading in a zone is higher than the average.
- The error is negative if the caliper reading in a zone is lower than the average.

Thus the error profile shows how far the caliper in each zone deviates from the average. For example, if the average across all the zones is 20 mils, and the caliper of the paper in Zone 18 is 20.67 mils, the filled bar for Zone 18 indicates an error of 0.67 mils.

Variability in the Error Profile

The 2sigma measure indicates the variance in the caliper of the paper across the width of the sheet: Approximately 95% of the caliper readings are at the average caliper $\pm 2\sigma$. For example, if the average caliper is 20.00 mils and 2sigma is 0.46 mils, 95% of the values for caliper in all the zones lie between 19.54 mils and 20.46 mils. The higher the value for 2sigma, the more variable the caliper readings across all the zones.