

Asphalt Paver Handbook

For Cat[®] F Series
Large Asphalt Pavers



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Do not operate or work on machine unless you have read and understand the instructions and warnings in the Operator and Maintenance Manuals. Failure to follow the instructions or heed the warnings could result in injury or death. Contact any Cat Dealer for replacement manuals. Proper care is your responsibility.

Important Safety Information

Most accidents involving product operation, maintenance and repair are caused by failure to observe basic safety rules and precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this presentation and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or other persons.

The hazards are identified by the “Safety Alert Symbol” and followed by a “Signal Word” such as “WARNING” as shown below.

The meaning of this safety alert symbol is as follows:



**Attention! Become Alert!
Your Safety is Involved.**

(continued on page 4)

Operations that may cause product damage are identified by NOTICE labels on the product and in this presentation.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this presentation and on the product are therefore not all inclusive. If a tool, procedure, work method or operating technique not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and others. You should also ensure that the product will not be damaged or made unsafe by the operation, lubrication, maintenance or repair procedures you choose.

The information, specifications, and illustrations in this presentation are on the basis of information available at the time it was written. The specifications, illustrations and other items can change at any time. These changes can affect the service given to the product. Obtain the complete and most current information available.

An asphalt paver is a machine that is used for road construction. The asphalt paver typically uses bulk material for the placement of paved surfaces. Most commonly, hot mix asphalt is supplied by vehicle delivery to the paver's front hopper.

The asphalt paver is a heavy duty machine that can place paving surfaces for many applications. The asphalt paver can be used for numerous applications such as roads, city streets, parking lots, highways and motorways. The asphalt paver accepts delivery of asphalt mix from a truck or transport vehicle at the front. The asphalt paver then contains the mix in a hopper. Slat conveyors transport the mix from the hopper to the rear of the machine. The mix flows onto the ground ahead of the screed. The screed shapes the mix to specified dimensions. The screed also levels the mix to specified dimensions. The slope and the grade of the asphalt surface is precisely controlled by sensors and references that are mounted on the paver. This system achieves a high degree of flatness. The paver can be configured with different types of screeds to satisfy common customer's requirements.



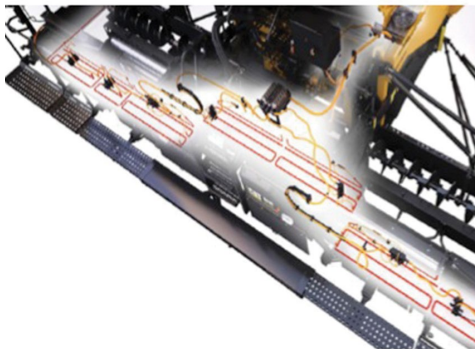
Falling off of the machine could cause serious injury or death. No riders while machine is in travel mode. Refer to Operation and Maintenance Manual, “Roading the Machine” for proper roading procedures. Always wear a seatbelt.



Producing a smooth asphalt surface with a uniform finish is not as simple as saying “one—two—three.” But a well-trained paver crew, which follows a set of established fundamental practices, will avoid many of the problems that affect mat quality.

The purpose of this presentation is to review the steps you should follow each time you get ready to pull off the joint and start paving.

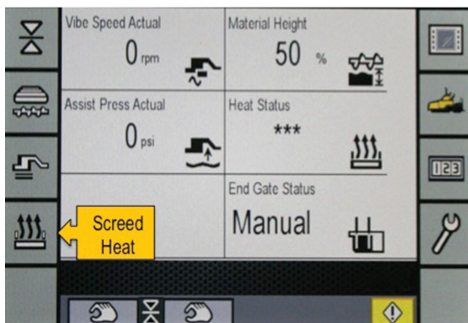
NOTE: This presentation should be used for the 3 m (10 foot) F-series paver with a SE60 V XW. This does not take the place of the Operation & Maintenance manual. Please refer to this manual for further explanation about the proper use, safety warnings and control of the machine.



STEP 1: Heat The Screed

If the screed is cold, you have to heat it before beginning to pave to prevent asphalt sticking to the screed plates. There are several types of screed heaters on Cat screeds, diesel fired, liquid propane and electric element. In this presentation, we will talk about the electric screed heat only. If you need information on the Diesel or Liquid Propane screed heat, please refer to the Operation & Maintenance Manual (O&MM) for that screed.

On Cat extendable-type screeds, each screed frame section is equipped with a heater. One on each screed extender and two on the main screed.

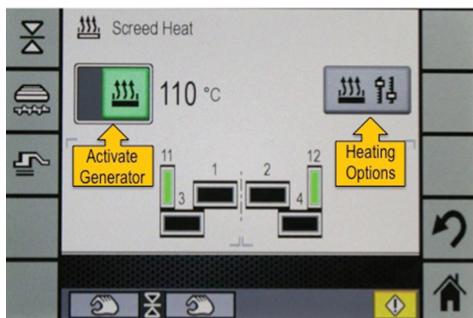


STEP 1: Heat The Screed (*Continued*)

The F-series asphalt paver has two spots to activate the heating system. This can be achieved on the left or the right tractor operator station or on the left or right screed operator station.

Choose the screed heat icon. (Screed operators station screen shown)

Start with the screed approximately 25-75 mm (1-3") off of the ground. If the screed is at maximum height, wind can effect the performance of the heaters. Also if the screed is on the ground, the ground acts as a heat sink and it will take longer for the screed to come up to temperature.



STEP 1: Heat The Screed (*Continued*)

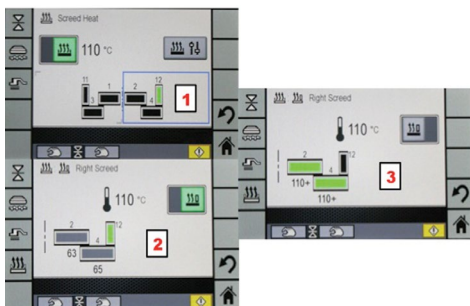
The generator icon is located on the left side of the screed heat screen. Touch the screen symbol and slide to the right. When activated the icon will turn green and the engine rpm will raise to 1300 rpm and the generator will be activated. The temperature set point can be chosen by selecting the heating option icon on the right hand side.



STEP 1: Heat The Screed (*Continued*)

In the heating options menu, the operator can choose the Temperature title. Under this screen, three temperature set points can be chosen. These set points are 110°C (230°F), 130°C (266°F), or 160°C (320°F). Once the temperature choice has been made, touch the Home icon and continue with the setup of “Paving by the Numbers” instruction.

Once the generator has been turned on and the temperature has been chosen the screed will heat up.



STEP 1: Heat The Screed (*Continued*)

The operator can view the status of the screed heat by touching the zone section (1). The color of the viewed zone will be black, grey (2) or green (3) (see color explanation below). Once all the zones have turned green paving can begin.

NOTE: Picture (2) shows the optional end-gate heater turned on and both the heater and the on/off button is shown in green. In picture (3), it is shown turned off and is black.

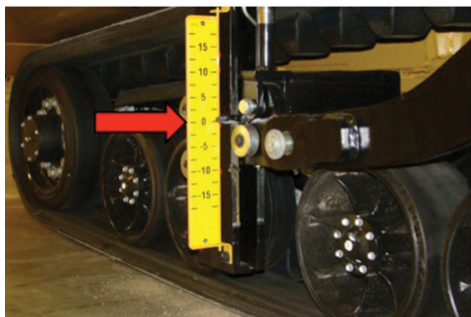
Temperatures of color changes:

Heat Setting / Black / Grey / Green

110° C (230°F) = 0° – 59° C (32°-138°F) / 60° - 109° C (140°-228°F) / 110° C+ (230°F+)

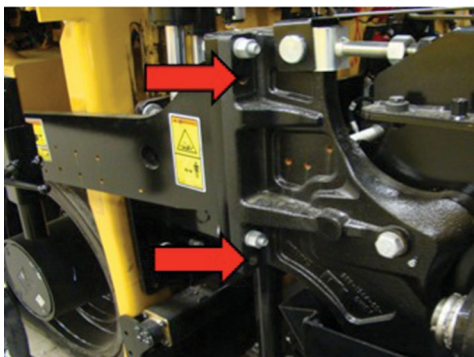
130° C (266°F) = 0° - 79° C (32°-174°F) / 80° - 129° C (176°-264°F) / 130° C+ (266°F+)

160° C (320°F) = 0° - 109° C (32°-228°F) / 110° - 159° C (230°-318°F) / 130° C+ (320°F+)



STEP 2: Position The Tow Arm Cylinder

Step 2 is positioning the tow arm cylinder for the correct "line on pull" for the depth that is being paved. On the F-series paver, the position of the screed attachment point can be placed in a position for shallow paving 0-18 cm (0-7 in) or deep depth paving for 18 cm – 30 cm (7-12 in). For shallow paving setup, the operator should adjust the position of the tow arm pointer at "0" if paving 7.5 cm (3 in) or less. When paving at depths more than 7.5 cm (3 in), the operator should adjust the cylinder at the rate of 2.5 cm (1 in) per 2.5 cm (1 in) depth increase.

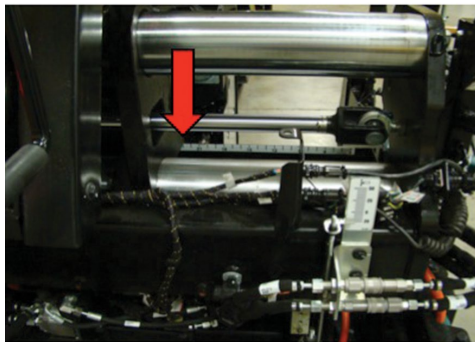


STEP 2: Position The Tow Arm Cylinder (Continued)

Deep Depth Tow Arm Position: The F-series can be setup to pave deep depth. To do this, reposition the tow arm attachment on the drop arm to the bottom set of holes. This will give the depth range of 18 cm (7 in) – 30 cm (12 in).

When paving at this depth the tow arm will need to be positioned in the proper location.

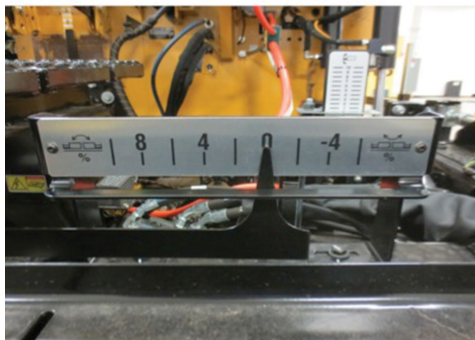
	Loose Mat	Tow Point Position
Deep Depth Paving 18-30 cm (7-12 in)	18 - 23 cm (7-9 in)	0-2.5 cm (0-1 in)
	23 - 30 cm (9-12 in)	2.5 - 7.5 cm (1-3 in)



STEP 3: Set Paving Width

With the screed still raised, move the extenders out to the proper paving width. When setting this up you will want to keep in mind the main screed width then add the additional width to meet the job specification. Each extender has a scale which shows how far the extender is moved out from the main screed.

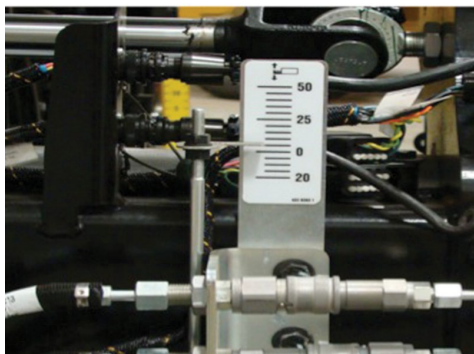
It is good paving practice to set equal extender width on each side whenever possible so the forces against each extender are equal. For example, if the job specifications are a total width of 12 ft (3.66 m), on the SE60 V / SE60 V XW the main screed measures 9 ft 10 in or 3 m, to achieve the proper width move the left and right extenders out an equal amount of 13 in (0.33 m) on each side. This will achieve the proper width required.



STEP 4: Set The Crown

Set the main screed crown to the specifications of the job.

Use the crown indicator scale located on the right side of the screed to set the crown. Before using the indicator scale, be sure that it is properly calibrated to the screed.



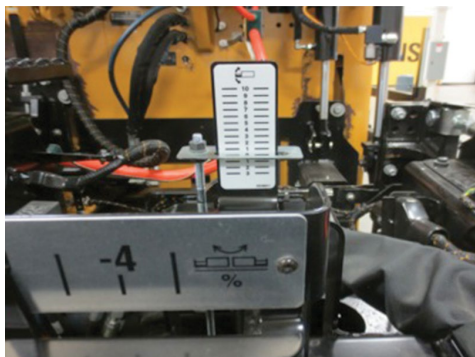
STEP 5: Set Extender Height

Set the height of the extenders so they match the height of the main screed. When the extender height is right, there are no transition marks in the mat.

Extender height is adjusted with a push button in each screed control box on vibratory screeds.

The SE series of screeds normally run with a 5 mm (3/16 in) nose-up angle of attack. Therefore, on a screed with rear mounted extenders, set the extender height 5 mm (3/16 in) above the zero point on the scale. Do this for both left and right extenders.

Again, make sure that the height indicators have been calibrated to the extenders.

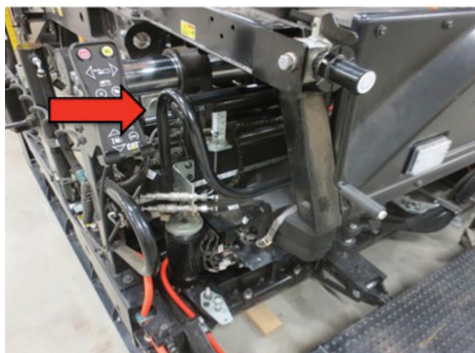


STEP 6: Set Extender Slope

Set the slope of the extenders to the specifications of the job.

If there is no requirement for extender slope, set the indicator at zero on both sides.

Again, make sure that the slope indicators have been calibrated to the extenders.

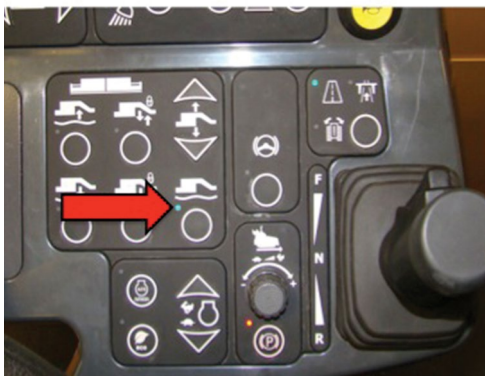


STEP 7: Lower The Screed

In this step we first want to raise the end gates to the proper position to ensure that the screed rests on the starting reference and not the end gates.

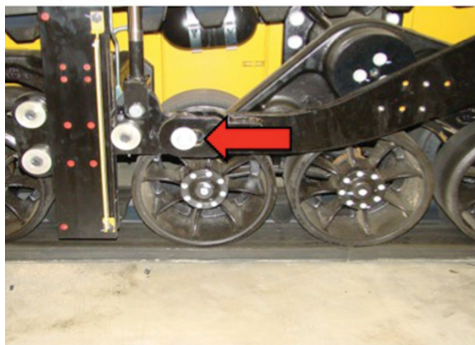
Then select a starting reference whose thickness matches the uncompacted mat depth that will be placed by the screed. Normally, the mat will compact about 6 mm (1/4 in per inch) per 25 mm (1 in) of mat depth. For example, to get a 50 mm (2 in) compacted mat, use a starting reference which is 64 mm (2-1/2 in) thick. Use two references. Position them so they are under the pivot of the extender and completely supporting both the main screed and the screed extender from front to back. The normal length of the starting references are between 0.9 - 1.2 m (3 - 4 ft).

NOTE: With the extenders beyond the halfway point, an additional starting reference for the extender may be required.



STEP 7: Lower The Screed (*Continued*)

After placing your starting references, lower the screed by pressing the screed float button, making sure that the green light is illuminated next to the button. The screed is now in float and should lower to the references.



STEP 7: Lower The Screed (*Continued*)

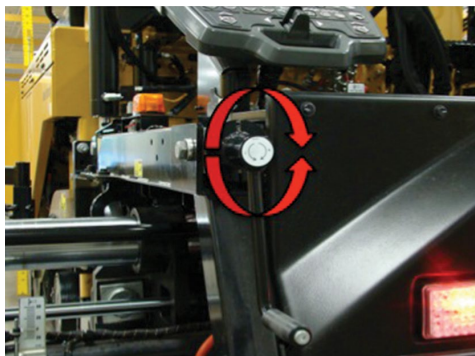
Step 7 also includes removing the slack from the tow arm. Move the machine forward until the tow arm roller contacts the tow point frame and both sides of the screed begin to move forward.



STEP 8: Nulling The Screed

Use the manual depth control cranks to null the screed. Nulling the screed should be done on one side of the screed at a time. Turn the crank in either direction until no resistance is felt. This ensures that the full weight of the screed is supported by the starting reference. Move to the other side and follow the same nulling procedure. Be sure the crank turns freely. Then, go back to the other side. Make sure the crank still turns freely.

NOTE: Repeat this until both sides have no resistance.

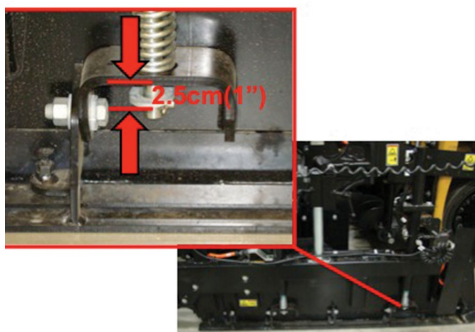


STEP 8: Nulling The Screed (*Continued*)

Then, turn the depth control crank in the direction that increases mat thickness until resistance is felt.

On the other side, turn the crank until you feel resistance.

On other types of screeds, you may have to turn the depth control cranks one or more revolutions to set the angle of attack. Follow the manufacturer's guidelines for the screed you are setting up.



STEP 9: Position The Endgates

End gates on both ends of the screed retain material at the proper width. They float on the grade. First, lower the end gate until it touches the grade. On manual gates, raise or lower the spring tension to create 2.54 cm (1 in) space between washer and bracket to allow for the end gates to move up and down over any grade irregularities. On the hydraulic power end gates lower them to the grade and press the “auto” button or raise even with bottom of the extender plate depending on the requirements.



STEP 10: Set The Auger Height

The height of the augers in relation to the depth of the uncompacted mat has an effect on the texture and finish of the mat. If the augers are too low, you will probably see an open texture and maybe material segregation. If the augers are too high, the head of material will likely be too high which will cause the screed to climb. Different mixes react differently to auger height adjustment, but as a rule, set the auger height at least 5 cm (2 in) above the height of the uncompacted mat. From the bottom of the auger to the center of the auger shaft is 20 cm (8 in). Now add 5 cm (2 in) to that. Then add the thickness of mat to be paved. The total is the distance from the centerline of the auger shaft to the grade. Adjust the auger up or down until the dimension is reached. Fine tune the auger height after paving starts if the mix is very coarse or very tender.



STEP 11: Set Feeder Sensor Position

Position the paddle type feeder sensors so they are sensing the active pile of material about 46 cm (18 in) away from the last auger segment. With the paddle-type sensor, the paddle arm should be at a 45 degree angle at the 46 cm (18 in) distance.



STEP 11: Set Feeder Sensor Position (*Continued*)

Sonic feeder sensors should be set perpendicular to the material flow 46 cm (18 in) away from the material. Always target the moving material.



STEP 12: Set Feeder Controls

On the left side of the tractor control panel touch screen, select the material feed adjustment icon.



STEP 12: Set Feeder Controls (*Continued*)

Set the conveyor control dials to 40% for each conveyor. Using the arrows on the touchscreen, adjust the mix height to 60%. After adjustments are made to the mix height push the OK icon on the touchpad to accept the setting. This is a starting point for the system. The operator or screed operator can fine tune these when paving begins.



STEP 13: Fill The Auger Chamber

Now fill the auger chamber in front of the screed until the material is covering one half the auger.

Fill the chamber with the engine at low idle, one side at a time, alternating between the conveyor and auger. This helps prevent material from being pulled under the machine and overfilling the chambers.

Using the manual override switches, alternately convey and auger material to the auger chamber and out to the ends of the augers.

The goal is to fill the auger chamber evenly on both sides.



STEP 13: Fill The Auger Chamber (*Continued*)

Use one conveyor switch at a time to move material out until it just touches the auger shaft.

Then, use the manual auger switch to move material out to the end of the screed. The correct head of material covers one half of the augers.

Always fill the auger chamber using the manual mode at low idle and be careful not to overfill.

NOTE: Do not fill the chamber using the conveyor and auger switches together or by using the feeder override switches located on the screed. This will overfill the chamber and cause a bump on take off.



STEP 13: Fill The Auger Chamber (*Continued*)

Do not force material out to the end gate. You will overfill the chamber. Instead, move some material with a shovel to the end gate even with the face of the main screed.

NOTE: Do not fill in the area directly in front of the extender on rear-mounted extender screeds. This area will be filled by material automatically as the paver pulls forward off the starting reference.



STEP 13: Fill The Auger Chamber (*Continued*)

When you have filled the auger chamber half full—no more, no less—put the conveyor and auger mode switches on the operator's console to Auto. Either push the automatic conveyor and auger button or press individual automatic buttons for both the conveyor and auger. Verify that all four automatic system indicators are illuminated.



STEP 14: Set Accessory Functions

At this point it needs to be determined what accessory functions are going to be used on the machine.



STEP 14: Set Accessory Functions (*Continued*)

Automatic grade and slope controls are considered accessory controls. Set them according to the job specifications. Install any averaging devices and controls as required.



STEP 14: Set Accessory Functions (*Continued*)

Step 14 is setting the accessory functions of the machine.

Refer to the machine Operation and Maintenance Manual for all the functions on the machine. Here are just a few:

- Automatic Engine Speed Control
- Friction Steer
- Vibrator System On/Off and Speed
- Screed Assist System
- Timers
- Propel Hill Hold



STEP 15: Pull Off Starting Reference

Make sure the gear selector is in the PAVE mode (1), the screed is in float (2), and the engine throttle is set at the chosen idle speed (ECO or high idle) (3). Then, turn the speed control dial (4) clockwise until the calculated paving speed is displayed in the target speed area of the display (5), release brake (6). Propel the machine by squeezing the trigger and stroking the propel lever (7) full forward in one quick, smooth motion.

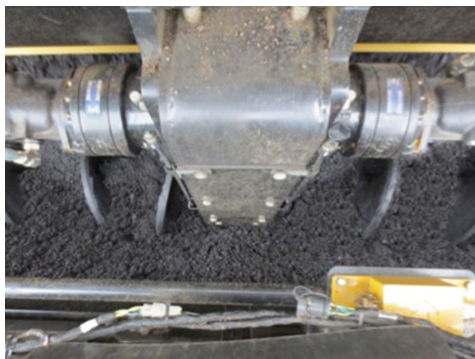
NOTE: When calculated target speed is reached, use the propel lever to stop and start the machine using the same quick, smooth motion as before. Slowly stroking the propel lever will result in a more uneven head of material and have an adverse effect on mat smoothness.



STEP 15: Pull Off Starting Reference (*Continued*)

Screed personnel observe the level of material at the outboard ends of the auger shafts to see if the auger shafts are one half covered.

There are individual material height dials on the screed control boxes which are adjusted to control the height of material at the outboard ends.



STEP 15: Pull Off Starting Reference (*Continued*)

As the paving operation stabilizes, the operator should check the speed of auger rotation. The augers should be turning uniformly in the range of 20-40 rpm.

To slow down the augers, the operator turns the ratio control dials clockwise. This action sends more mix to the auger chamber. To increase auger speed, turn the conveyor ratio control dials counterclockwise.

By all means, avoid erratic or ON/OFF operation of the augers. These conditions tend to create material segregation stripes in the mat and loss of smoothness.



STEP 15: Pull Off Starting Reference (*Continued*)

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No Separation Marks In Mat
(Rear Mounted Extenders)



STEP 15: Pull Off Starting Reference *(Continued)*

As paving speed and feeder system operation are stabilized, screed personnel should look for transition marks between the main screed and screed extenders.

If screed height, angle of attack and slope are correct, the mat should have a uniform texture across the full width of the mat and there should be no longitudinal lines present.

**Extender Screeds Too Low
(Rear Mounted Extenders)**



STEP 15: Pull Off Starting Reference (*Continued*)

If an extender is set too low, there will be a longitudinal transition mark in line with the inner edge of the screed extender. The mat will be thinner behind the screed extender.

Use the extender height switch to raise the extender until no transition mark is present.

**Extender Screeds Too High
(Rear Mounted Extenders)**



STEP 15: Pull Off Starting Reference *(Continued)*

If an extender is set too high, there will be a longitudinal transition mark in line with the outer edge of the main screed. The mat will be thicker behind the screed extender.

Use the power height switch to lower the extender until no transition mark is present.



The most important fundamental of smooth paving is maintaining a consistent paving speed and constant head of material.

Normally, you can set up the paver to pave smoothly at any speed that matches the delivery of mix to the job site. **The important thing is to keep the speed constant on all systems.**

If the paving speed is changed drastically, the screed will either rise or fall and mat smoothness will suffer.

Also, if paving speed changes, the demands on the feeder system change. So the feeder system controls will have to be adjusted to match the new material demands. For quality paving results, always follow the basic fundamentals of paver set-up and keep the operation consistent.

F-SERIES GRADE AND SLOPE



The Cat Grade & Slope System for the F-Series Asphalt Pavers uses high accuracy sensors and software to control the screed's relative vertical position to a control reference during paving operations. The system can be configured for operation with one or more mechanical and sonic sensors.

On the F-series Asphalt Paver any of the four displays allow operators to monitor and adjust system parameters through a graphical user interface.

For more information regarding the Caterpillar Grade and Slope System for the F-Series Asphalt Pavers refer to the Operation & Maintenance Manual or the booklet Grade & Slope F-Series Pavers (Form #: QEDQ1959)



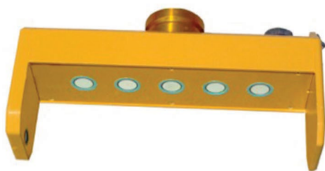
The Grade and Slope Electronic Control Module (ECM) receives operator inputs from the machine displays via a network of CAN bus and Ethernet communication lines. These inputs are analyzed, the ECM then works in conjunction with the machine systems to control the tow points.

The system has the “Auto Valve Calibration” feature which executes a calibration program that allows the system to determine the response of the valves to valve drive commands with no manual intervention.



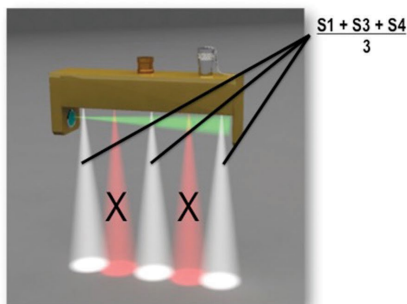
The control system is integrated into the displays on the tractor and on the screed. The operator no longer needs to install or remove the control system panels from the paver making it quicker and easier for the crew to prepare the machine at the beginning of the shift or at the end.

The sensors are the same as earlier Cat Grade and Slope so they can be used on the new system.



The ST200 is an elevation control sensor. The sonic tracer contains five sonic transducers and one temperature compensation transducer.

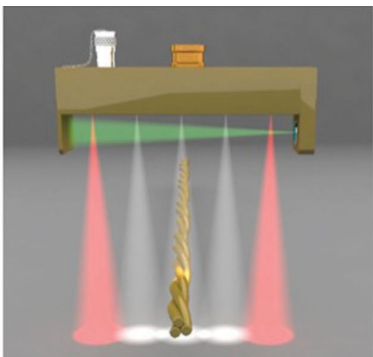
The transducers emit sound pulses that reflect off physical objects, such as a surface or a string line. As the sound pulses strike an object, a portion of the sound pulses reflect back to the transducers. By using the speed of sound, the sonic tracer calculates the exact distance to the control reference by using the elapsed time for the reflected pulse to return to the transducer. Once the sonic tracer has been nulled, any change in distance will be sent to the control system. The system evaluates the information, and sends a signal to the ECM to raise or lower the tow point cylinder.



The temperature sensor signal bounces off of the end plate on the sensor. This distance is fixed so any change in the speed of sound that is thermally induced is evaluated by the system software and changes are made, if needed, to the tow point position.

The working range for the sonic tracer is 20 cm (8.0 in) to 100 cm (39 in) and has an adjustable working window.

In surface mode, the five transducers average the surface of the reference object. The sonic tracer must be mounted parallel to the direction of travel with the connector to the rear. The sonic tracer must be configured for surface tracking by using the Sensor Select icon and choosing the correct icon on the display touch screen.



In string line mode, the three center transducers average the string line and the two outer transducers signal the display for horizontal guidance.

The sonic tracer must be mounted perpendicular to the direction of travel with the connector on the left when viewed from the rear. This enables the guidance arrows on the display to be directionally correct.

The sonic tracer must be configured for string line mode by using the Sensor Select icon and choosing the correct icon on the display touch screen.



An averaging ski is an elevation control device. The ski is mounted on swing arms attached to the tow arm. The ski removes small surface irregularities and averages out longer surface irregularities. You can use up to three ST200 sonic tracers on the averaging ski in the following combinations:

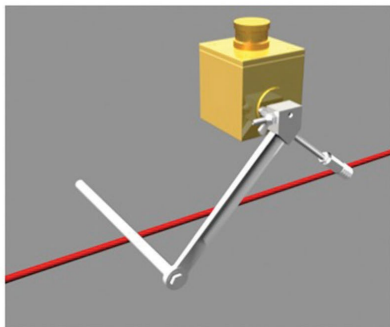
- Three sonic tracers spaced at equal distances from each other.
- Two sonic tracers with one mounted at each end of the beam.
- One sonic tracer mounted in the center of the beam.

The readings from each active sonic tracer on the ski are averaged in order to provide a smoother reference elevation.

The ski articulates to enable the rear sonic to be positioned over the finished mat.



The CS200 is an elevation control sensor and can be used with a profile ski. The sensor should be set up and nulled/surveyed with the wand arm at a 45° angle trailing the sensor with the connector facing forward. The contact sensor is unaffected by temperature variations and measures the changes in the elevation of a control reference which could be a ski, curb, existing mat or existing grade by measuring the change in angle of the wand arm.



The CS200 rotary contact sensor can also be used with a string line wand to reference an object. When mounted correctly the wand arm will be facing to the rear and will be at a 45° angle with the wand centered on the string. The wand pressure can be adjusted and configured to reference above or below a string-line. Once the contact sensor has been nulled/benched, any change in the elevation or wand angle will be sent to the display. The display evaluates the information and sends a signal to the ECM to raise or lower the tow point cylinder.



The AS200 angle sensor is a sensor that functions as a precision carpenter's level. The angle sensor reads the slope of the screed and sends an electronic signal to the display. The angle sensor contains an electronic device that will constantly measure the slope of the screed. The AS200 angle sensor is mounted on the transverse beam of the screed.

The sensor is calibrated by editing the slope value in the measured values area. This enables the operator to maintain a desired positive or negative slope from $\pm 10^{\circ}$ ($\pm 17.6\%$) but is limited by machine capabilities.



Because the tractor display is a full touch screen display, the operator **MUST** push the Display unlock button (1) for the touch function to work. The LED light must be lit for this operation. At that time the touch functions will be allowed. The operator can then access the Grade and Slope system interface by touching the Grade and Slope Icon (2) from any screen that shows the icon.

NOTE: After three minutes the display will automatically lock again.



The screed display is a combination soft key button and/or touch screen. The operator will need to press and release the Grade and Slope soft key button from any screen that shows the icon to enter the grade and slope system interface.



There are two different types of displays on the F-series paver that serve as the operator interface for the Cat Grade and Slope system. The operator on the tractor has a total touch screen display that has no external buttons. This display does not have any internal or external light bars for grade indication. The screed operator display has a combination touch and soft key button control interface with internal and external light bars for grade indication. These displays will perform the same functions but the operator interface will be slightly different on each.

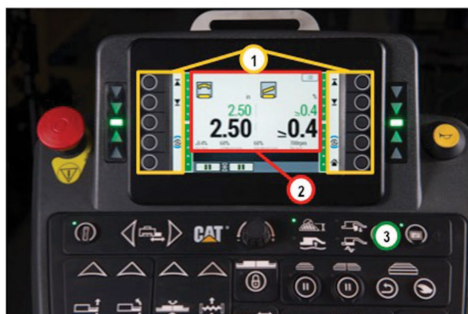
NOTE:

- **Tractor displays only allow dual screen mode (shown).**
- **Screed displays can be set to dual screen mode or single screen mode (shown).**



Once in the Grade and Slope operating interface on the tractor, the operator will see in the lower left corner, a padlock icon (1). This icon is used to: unlock only the icons on the sides (2) of the display, go to the previous screen, or “okay” a new setting or change made. The unlock function (1) will only work for three seconds or one icon button touch. The system operates in this way so no “unwanted” change happens unless the operator requests it. Area (3) is allowed without having to touch the Lock icon (1) but when a value is changed you will have to “okay” the change and that requires the use of the Lock icon (1).

NOTE: The Tractor display is a full touch screen so remember, the screen must be unlocked first before the touch function works as explained in slide three and after three minutes the display will automatically lock again.



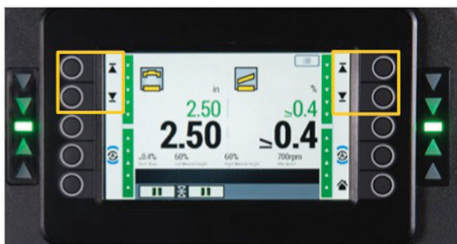
The screed displays are a combination touch screen and/or soft key function. In area 1, the operator can only use the soft key buttons to utilize those functional icons. In area 2, the operator can use the touch screen function or a combination of soft key button and touch screen. Remember for touch screen operation, the screen must be activated with the display unlock button on the key pad (3).

NOTE: The menu structure is the same with either display, but the operator interface is different between the two. This presentation will use the Screed Display to explain the operation of the system.



The middle section of the screen is called the Guidance Screen. The Guidance screens display a mix of text and graphics that provide information such as the slope and elevation or different menus. There are many different sections to this screen that will be explained within this presentation.

NOTE: Dual screen mode shown.



The soft keys adjacent to the arrow icons can be used in different ways. When an operator wants to use these arrow keys to move the tow point cylinders, they must first actuate the machine logic to allow for movement.

To accomplish this, the operator will need to place the machine in the active mode or meet the “**Paving Parameters**” which are:

1. Engine Running
2. Place the Propulsion Mode Switch in the **Pave Mode**.
3. Place the screed into **float**.
4. Parking Brake “**On**”.
5. **Squeeze propulsion trigger and stroke propulsion handle forward.**

Once the “Paving Parameters” are met, the operator can press the arrow soft key buttons and manually raise or lower the tow point cylinders to the required position.

In the Automatic mode, the operator can change the “target” value for elevation or slope.

When in the Configuration Mode the operator has the ability to select a desired menu item and change the values.

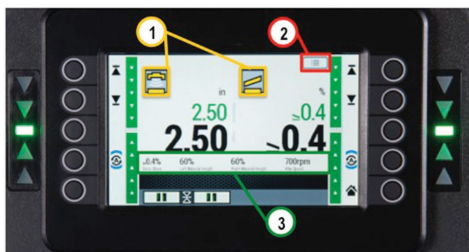
NOTE: While paving, the Paving Parameters must also incorporate the “Target speed above zero” to allow for automatic operation.



Item 1 is the Bench soft key. This function is only present in the manual mode, the icon will disappear when placed in the Automatic mode. Press and hold the soft key for three seconds to bench the position or height of the grade sensor to the reference. When in the slope mode, this will bench the position or angle of the screen.

Item 2 is the Automatic / Manual mode soft key. This function will place the system in the Automatic control mode (control of tow point cylinders) or in the Manual mode (no control of tow point cylinders) when pressed and released.

Item 3 is the Home or Machine Health soft key. When pressed and released the system will be taken out of the Grade and Slope system screens. If the operator is in the automatic mode, the system will continue to control the tow points at the benched position.



Item 1 is the Sensor Select icon. This is a touch screen item that allows the choosing of an available sensor that is attached to the machine. Icons will appear with the available plugged in sensors.

Item 2 is the Menu/Operator setting icon. This icon is also a touch function. This menu allows the operator to configure or customize the grade control system, to use system diagnostics and/or to calibrate the system.

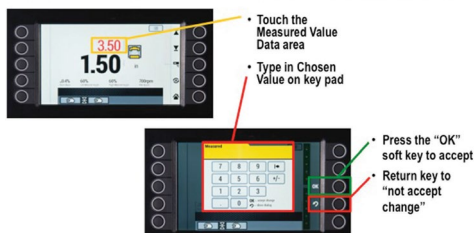
The last item, 3, is the text slider bar. The text slider bar allows the operator to view configurable information about different machine and screed system settings while in the Grade and Slope system screen. If the operator touches the text slider bar with one finger and slides it to one side or the other they would be able to view several pieces of information.



The Measured Value area (1) shows the actual sensor data in real time. When the sensors are configured and/or calibrated and the screed rises or falls the actual sensor data that it sees will be displayed in this area.

In the Target Value area (2), the values displayed are the targeted elevation or the targeted slope of the screed.

The configured or calibrated numbers for these areas can be adjusted by following the instructions on the next slide or page.



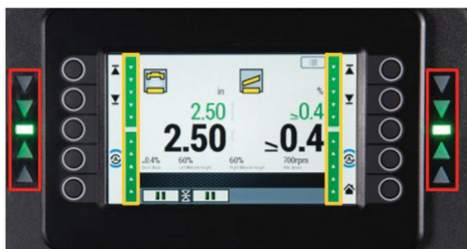
The operator can edit the value in the measure values data area by touching the screen. A key pad will appear on the screen. The operator touches the value they wish to display in this area. Once complete, the "OK" soft key must then be pressed to accept the number chosen. It is common practice to use the value that is measured while paving whether in the grade mode or the slope mode. If editing the number in the slope mode, the correct angle direction must be chosen also.

NOTE: If this action is done in the manual mode, the system must be re-benched. If it is done in the automatic mode, the number will automatically be pushed to the target value data area.



The "Target" is the position you want the screed to be at or drive to. If the target data area on the display is touched a key pad will appear. The operator can choose a new target. In the Automatic Mode if a new target value has been added and the "OK" soft key is pressed the system will automatically drive the tow point to the new target position if the paving parameters have been met, so care must be taken when doing this operation.

In the manual mode the number will change but the system won't drive to the new target unless the operator goes into the automatic mode and has met the paving parameters.

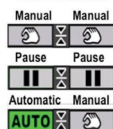


There are two different types of indicators on this Grade control system. There is the internal vertical graph light bars which are located on the touch screen and external bars that are located on the outboard side of the display. The operator can configure these light bars to work in the automatic mode only, in the automatic/manual mode, or turned off. The external light bars have two different color LED's, amber or green and the internal is either red or green. The flashing pattern of these indicators change depending on the state of the grade control correction. For a detailed explanation on the indicators refer to the owners manual for this system. The brightness of these indicators will follow the screen brightness setting when adjusted.



- Area tells the status while operating

- Shows in all views



On the bottom lower banner of the Guidance screen there is a block that shows the status of the grade control system. This lower banner will be present no matter what view the operator is looking at whether it is the grade control screen or one of the machine health screens. In the picture shown, the Paver is in the Automatic mode on both sides of the machine and the machine is moving (Paving Parameters met). When the system has both sides set to the manual mode, two manual mode (hand) icons will be shown. If the paver operator has the propulsion lever in neutral with the grade control in the Automatic mode, the “Pause” icons will blink alternately with the “Auto” icons. When one side of the paver is in Automatic mode and one is in the manual mode, the side activated in automatic will have the “Auto” icon and the other side will show the Manual mode icon.

Preparing to Pave (Grade)



Preparing to Pave (Grade)

First, set up the paver using Paving by the Numbers. Then choose the proper sensor type by touching the Sensor Select Icon. Once the proper sensor is selected press “Okay” soft key. The sensor is now chosen.

NOTE: Only the sensors that are plugged into the machine will be available for use.

Preparing to Pave (Grade)



Preparing to Pave (Grade) (*Continued*)

The position of the sensor along the tow arm determines how fast the screed will react to a change. By positioning the sensor, we can build profile or rideability. We need to evaluate job specifications and grade related conditions to determine the desired position that will produce the required results.

Automation sensors will always move the tow point up or down to maintain the sensors bench point or null point. In effect, the location of the sensor becomes our only control point. The tow point becomes only a point from which we raise or lower the tow arm to reestablish the bench point or null point at the sensor. The effective length of tow arm becomes the distance between the control point (sensor) and the pivot point (trailing edge of the screed).

Preparing to Pave (Grade)



Because the screed must travel five tow arm lengths to fully react to a correction, shortening the effective tow arm length shortens the distance the paver must travel to complete a correction. Positioning the sensor to the rear or inline with the auger shaft produces a quick change (or reaction) of the screed. This placement will have a 4 to 1 ratio. Meaning that for every 2.5 cm (1 in) of sensor movement up or down, the tow point will move up or down 10 cm (4 in). This position is used to match existing surfaces or a curb line.

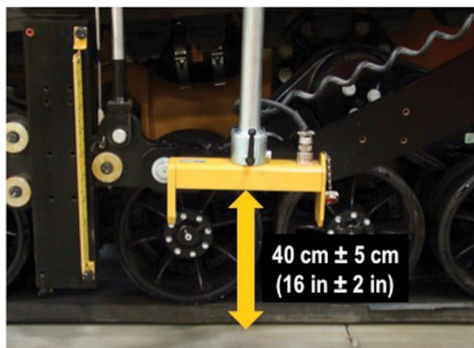
Rule: Sensor(s) positioned inline with the augers builds PROFILE.

Preparing to Pave (Grade)



Positioning the sensor forward or near the tow point causes gradual changes in tow point movement. Again, because the screed must travel five tow arm lengths to fully react to a correction, increasing the effective tow arm length increases the distance the paver must travel to complete a correction. Positioning the sensor near the tow point decreases reaction time of the screed. This placement will have a 1 to 1 ratio. Meaning that for every 2.5 cm (1 in) of sensor movement up or down, the tow point will also move up or down 2.5 cm (1 in). This position is used to build ridability or smoothness.

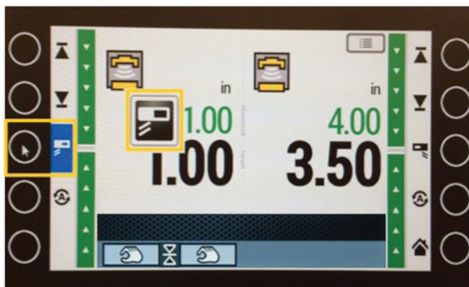
Rule: Sensor(s) positioned near the tow point or 1/4 of the tow arm length back from the tow point builds RIDABILITY.



Set the height of the grade sensor to 40.6 cm +/- 5 cm (16 +/- 2 in) or the angle of the wand arm to a 45° angle on the contact sensor above the reference.



Now adjust the number in the Measured Value Data area to display the actual paving depth that will be paved. To do this, touch the “unlocked” display Measured Value Data area on the Guidance screen. A key pad will appear on the screen. Touch the actual paving depth numbers on the screen and press the “OK” soft key to enter the value.



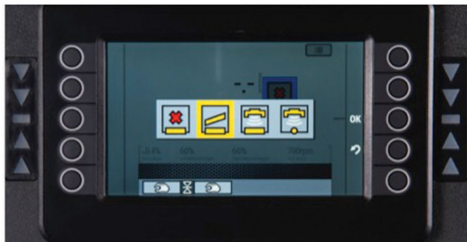
The sensor position height can now be benched. Press and hold the bench soft key until you hear an audible beep or until the bench icon appears on the guidance screen. This will tell the control system to hold the screeds current elevation position. Do this on both sides. This will also move the Measured data number that was entered to the Target value data position.



Press and release the Manual / Automatic soft key to place the system into the automatic mode. Repeat on the other side.

Once paving begins, the control system will adjust the tow point cylinders to maintain the selected reference point. If any adjustment needs to be made the operator can press the Arrow soft key the direction needed to maintain specification.

Preparing to Pave (Slope)



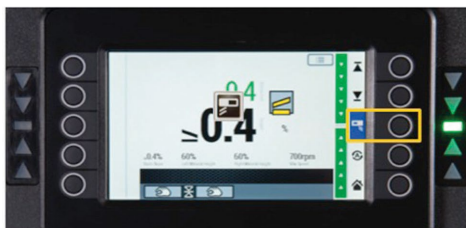
Preparing to Pave (Slope)

When preparing to pave under slope control, set up the paver and screed using Paving by the Numbers. Once this has been completed, touch the Sensor Select icon on the Guidance screen. Choose the slope sensor icon and press and release the “OK” soft key.

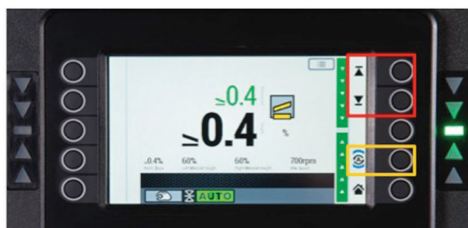
NOTE: The Display unlock button on the screed operator station key pad must be selected in order to utilize the touch screen function.

NOTE: Only one side can be selected for slope at a given time.

Preparing to Pave (Slope)



Press and hold the Bench soft key until an audible beep or until the bench icon appears on the Guidance screen, this benches the angle of the screed.



Press and release the Manual / Automatic soft key to place the system into the Automatic mode. This will allow the slope control system to control the tow point cylinder for that side actuated for slope. The control system will then control the angle of the screed when the paving parameters have been met.

If the screed angle needs to be adjusted, press the arrow soft keys up or down to make the required correction.

Preparing to Pave (Slope)



Preparing to Paving (Slope) (Continued)

If the guidance number does not match the slope of the mat being laid, the slope sensor will need to be calibrated. To do this, touch the Measured Data area on the Guidance screen. A key pad will appear on the screen. Touch the correct percent slope of the measured mat and also verify that the slope direction is correct. When the correct number and slope direction is entered press and release the “OK” soft key to lock in the calibrated number. The slope sensor is now calibrated and should match the mat being laid.

Auto Valve Calibration



Next, we will walk through the Auto Valve Calibration on the F-series Grade and Slope system. When the machine first gets the system installed a calibration must be done to store the characteristics of the tow point valves. The Grade control system applies electrical current to the tow point valves in order to determine the operating range of the valve. The operating range of the valve is critical in order to have a properly performing Grade control system. The calibration values will then be stored in the electronic control system so if a display is replaced a calibration will not be needed as those calibration values will be download upon power up of the machine and system. Caterpillar recommends performing the calibration periodically for optimum system performance. This calibration must be done when the tow point valves, cylinders or the hydraulic system has changed in someway.

Auto Valve Calibration



Auto Valve Calibration (*Continued*)

NOTE: The left and right valve calibrations are identical. Repeat this procedure for both sides of the machine.

NOTE: Calibration can only be done on one side at a time. Once the calibration has been started on the display do not interact with the Grade and Slope screens on the other displays or actuate any switches.

Auto Valve Calibration - Setup

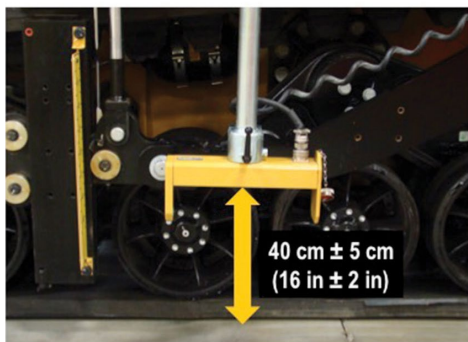


Occasionally there is a need to calibrate the F-series Cat Grade and Slope system, this task can be achieved very easily.

To start, move the machine to a flat surface. Then position each tow point cylinder so it has equal stroke up and down. Lower the screed by pressing the “Float” button on the instrument panel when in the **“Pave mode”**.

Slowly move the machine forward to remove any slack in the tow point assembly.

Next, null the screed so no tension can be felt in the thickness control screws.



Position the Sonic Tracer slightly behind the tow point pin. (As shown)

Position the Sonic Tracer as close to the machine as practical and without sensing the edge of the track.

Position the height of the Sonic Tracer $40\text{ cm} \pm 5\text{ cm}$ ($16\text{ in} \pm 2\text{ in}$) above the reference.



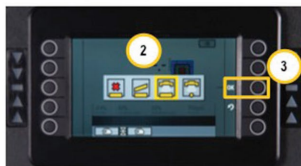
Next setup the paver controls so the system is active and it can be calibrated.

To do this:

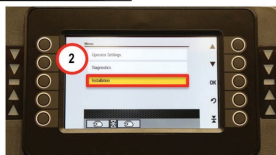
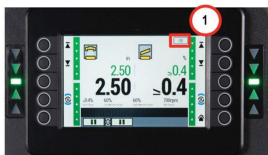
1. Apply the parking brake.
2. Place the Propulsion switch in the Pave mode
3. Place the screed into “Float”
4. Engine rpm to low idle
5. Squeeze the trigger on the propulsion lever and move to the full forward position

NOTE: Screed must be in “Float” or the system will NOT allow for the automatic calibration to be achieved.

The system hydraulics temperature must be at least 38° C (100° F), but normal operating temperature is preferred.



The ST200 is the only sensor that can be used for calibration. Touch the sensor select icon on the Guidance screen (1). Select the ST200 sensor icon for the “Surface mode” (2). Press and release the “OK” soft key (3).

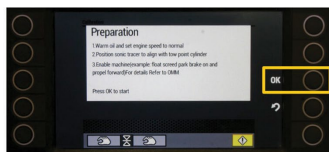


The machine is now set up in the proper position and the proper state to allow for final completion of the automatic calibration. Proceed to the Guidance screen. In the upper right hand corner touch the System menu icon (1). In this menu touch the Installation menu (2) choice.

NOTE: Going into the Installation Menu at anytime, when in “Automatic,” will place the system into the “Manual mode”.



At this time, choose the Calibration menu. The choices will be Left or Right Valve Menu's. Choose the side being calibrated by touching the screen or by highlighting and pressing the “OK” soft key, then proceed to the next steps and follow the directions.



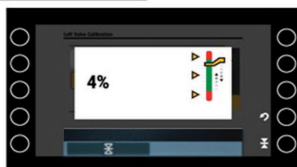
Since the machine was set up in prior steps (pages 79-85), the only step that will need to be completed when the “Preparation” menu appears is to press and release the “OK” soft key. The next screen will instruct the operator to store the position of the tow point cylinder. The cylinder should be positioned properly already but if not move cylinder to the middle of the cylinder stroke and press the “OK” soft key to store the middle position.



The next screen to appear is the lower motion limit. To achieve this step the operator must press the “down” arrow soft key to move the tow point cylinder approximately 76-100 mm (3-4 in) down from the middle position. Once this position is accomplished the yellow bar will move into the green zone. Note: If it is not in the green zone you will NOT be able to store that position. When in the green area, Press and release the “OK” soft key. The next screen will be for the upper motion limit. Press the “up” arrow soft key to move the tow point cylinder up until the yellow bar moves into the green zone on the screen. This position will be 76-100 mm (3-4 in) above the middle position. Again, once in the green zone press and release the “OK” soft key.

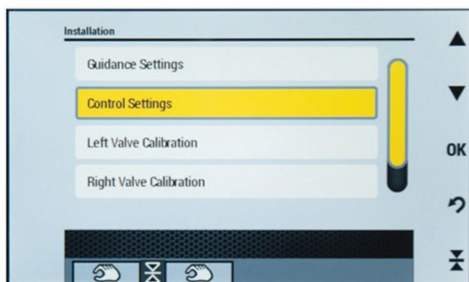


Once the positions have been stored, press the “OK” soft key to begin the calibration process. The system will automatically move the tow point cylinder locking in the proper currents to achieve the proper flow and speed of the tow point cylinder. This needs to be done on both sides of the machine because each valve has different characteristics. Once the system has completed the calibration process the screen will display “Valve Calibration Successful!”. At this time the operator must press and release the “OK” soft key to achieve the calibration.



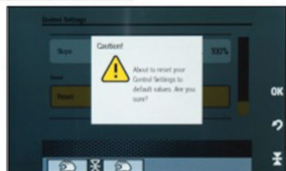
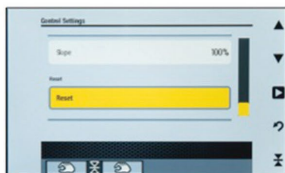
After the setup is complete, press and release the “Play” soft key. At this time the grade control system will automatically calibrate to achieve the proper system responses required to control the machine tow point valves. DO NOT activate any switches on the screen during the calibration process or the system will “abort” the calibration.

Once the screen displays “Valve Calibration Successful” the operator must press the “OK” soft key to complete the calibration.



If you run into a situation where you need to reset the system back to the factory defaults follow these steps.

Under Installation menu is the Control Settings menu. This menu allows for configuration of the Valve Speeds, the On-Grade Deadbands, Elevation Control Windows, Cross Coupling and Reset to Defaults submenus.



The Reset menu allows the operator to set all “Control Settings” back to default numbers. Resetting is recommended as a starting point if there are undesirable control characteristics.

NOTE: Resetting the default values will not reset the valve calibration values.



For further information on the Grade and Slope system for the “F” Series Asphalt Pavers please refer to the Operations and Maintenance Manual for your machine You can also refer to the handbook for the Grade and Slope system for the “F” Series Asphalt Pavers QEDQ1959.



AVERAGING SKIS ARE KEY TO SMOOTHNESS

The majority of state Departments of Transportation (DOT) now have payment incentives and penalties written into their specifications for pavement smoothness. Whether the specification is written around profilograph results or, more recently, around the International Roughness Index (IRI), project profitability may hinge on your ability to collect a significant amount of the available smoothness incentive.

It is now absolutely clear that proper use of averaging skis on ride incentive projects is the key to maximizing the amounts of incentives earned. While doing the fundamental things right, usually called

best paving practices, is still very important, the inclusion of averaging skis into standard highway paving practice has become a requirement

Continued on page 94

Skis come in various lengths and configurations. Some reference a target outside the paving width. Some reference inside the paving width. Some even extend over the screed. When selecting the right ski (mobile grade reference), two factors should always be considered first: (1.) the longer the better and (2.) the more articulation points the better.

A variety of averaging devices are available from Caterpillar and other paver manufacturers. Following is a review of the Caterpillar averaging skis.

Tips for Using Skis

1. Install any averaging device so the center of the string or beam is just behind the tow point cylinder. This is the ideal point for grade sensor location when ultimate smoothness is the goal. Remember, on a device like the Outboard Leveler, the center of the string will show the most reduction in grade deviation. The tow point reaction will be exactly the same amount as the sensed grade deviation and mat smoothness will be the best when the center of the string or beam is in this position.

2. Position the grade sensor (mechanical or sonic) in the middle of the string. Adjust the tension of a mechanical sensor arm so the arm maintains good contact with the string. Position sonic sensors $40\text{ cm} \pm 5\text{ cm}$ ($16\text{ in} \pm 2\text{ in}$) above the string.
3. Adjust string tension so there is no slack or vibration. Use string that is at least 3 mm ($1/8\text{ in}$) in diameter to provide a good target for sonic sensors. String must be a minimum of 10 cm (4 in) above beam.
4. Do daily maintenance on towed skis. The feet that contact the grade can pick up tack. Excessive tack build-up can cause the towed ski to vibrate excessively. Clean the ski feet at the end of each shift.

Using Two Skis

On any multi-lift project, install averaging skis on both sides of the paver for every lift after the bottom lift. On the bottom lift, it is common to operate with an averaging device on the centerline side of the paver and slope control for the shoulder side.

This will build the correct profile as specified in the project plan. If the profile of the structure is already correct, as is the case on some overlay or mill/fill projects, operate with two skis on every lift.

Continued on page 96

On smoothness projects, once the correct profile is built, your main concern is mat smoothness. So, look at the grade reference possibilities. Determine whether you can sense a reference outside the paving width or if you have to sense inside the paving width. Then, select the type of averaging device that best matches the paving application. Remember, the longer the better and the more articulation points the better.

Do not hesitate to use an averaging ski when matching a longitudinal joint. In the past, the conventional practice was to use a single sensor directly referencing the adjacent mat for joint match. A single sensor without an averaging ski produces a fast reacting screed, good for exact joint match but bad for smoothness.

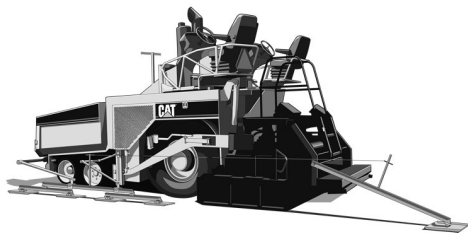
Ride incentive money is out there. You should be earning as much of it as possible on every project. Put averaging skis to work for you. You'll see better results.



OUTBOARD LEVELER

The Outboard Leveler is towed by the paver and references the grade outside the paving width. It comes in two lengths: 9.15 m (30') or 12.2 m (40'). It has multiple feet and multiple articulation points. It has the ability to reduce the amount of sensed grade deviation by a factor of eight. In other words, if a ski foot runs over a 25 mm (1") deviation, the center of the string running between the ends of the ski will move only 3 mm (1/8"). The grade sensor (either sonic or mechanical) will send a signal to the control box signifying a 3 mm (1/8") correction is required. The screed will make a small, slow correction and the deviation will be spread out over a long portion of the mat.

The Outboard Leveler is judged the ultimate averaging device for smoothness. It is recommended for highway projects when long pulls are the norm. Its main drawback, when compared to non-contacting averaging skis, is that it is harder to transport because of its size and number of moving parts.



FORE AND AFT LEVELER

The Fore and Aft Leveler mounts inboard of the paving width and bridges the screed extender to reference ahead of the screed and behind the screed. The front section is similar to the multi-articulated portion of the Outboard Leveler and the rear section is a wide foot that is towed by the screed and rides on the freshly laid mat. One significant benefit of the Fore and Aft Leveler is that the rear portion uses the smooth mat as a reference. This method is very popular when there is no suitable grade reference outside the paving width.

It is often used on the shoulder side of the paver in conjunction with the Outboard Leveler used on the centerline side of the paver.

It is used mainly on highway jobs with long continuous pulls. The rear foot must be heated prior to use on the hot mat. The rear portion blocks access to the outside of the screed extender.



SONIC AVERAGING BEAM

The Sonic Averaging Beam is the most recently developed averaging device. The beam is solidly attached to the paver and can be installed to sense the grade outboard or inboard of the paving width. Depending on the manufacture, the beam could be from 8.5 m to 9.1 m (28' to 30'). The signals from the three or four sensors, depending on ski, are combined and averaged by the automatic grade control box. Its averaging capabilities are somewhat less than the Outboard Leveler. It has become very popular for a variety of reasons. Because it is attached to the paver and does not contact the grade reference, it is easy to transport compared to “drag” skis. Because it can sense grade both outboard and inboard of the paving width, it has the most versatility and can be used for nearly any application. Since it is non-contacting, it does not pick up tack and requires less maintenance.



CONCLUSION

This book covers a lot of different things that hopefully will improve your paving operation.

Some of the key points to remember are:

Follow Paving by the Numbers.

Constant paving speed – Calculated at the beginning of every job.

Constant head of material – Keep the feed sensors adjusted properly and the head of material consistent.

Screed adjustments – Make minor adjustments giving the screed time to react. Remember the basics. It takes five tow arm lengths to complete a change made to the screed.

Grade sensor position – Know what you want to do and the type of reaction you need from the sensor.



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