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Preface

This manual has been developed to provide the operator with information necessary to operate and maintain the TOPCON machine control lasers. Proper service and use is important to the reliable operation of the equipment. The procedures described herein are effective methods for performing service and operation of this system.

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Manual Conventions

This manual uses the following conventions:

<table>
<thead>
<tr>
<th>Example</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power</strong></td>
<td>Press or turn this button or knob.</td>
</tr>
</tbody>
</table>

**TIP**

Supplementary information that can help you configure, maintain, or set up a system.

**NOTICE**

Supplementary information that can have an affect on system operation, system performance, measurements, personal safety.

**CAUTION**

Notification that an action has the potential to adversely affect system operation, system performance, data integrity, or personal health.

**WARNING**

Notification that an action will result in system damage, loss of data, loss of warranty, or personal injury.

**DANGER**

Under no circumstances should this action be performed.
Introduction and Setup

Topcon’s Grading System Five™ (Figure 1-1) is a complete control system allowing both survey and automatic operation of a blade, scraper, or other implement. The System Five includes the Control Box and a grade/elevation or slope sensor.

- For elevation control applications, connect a laser receiver or sonic tracker to the Control Box.
- For slope control applications, connect a slope sensor to the Control Box.

Figure 1-1. Grading System Five Components
Introduction and Setup

The heart of the System Five is the Control Box. Control Box functions can be set for particular machines or job applications.

The System Five™ Control Box can be connected to a grade sensor, such as a laser receiver, to control elevation, as well as a slope sensor to control the inclination or slope of an implement. The Control Box receives signals from the sensor and determines whether the implement is above, below, or at the desired grade. If a grade correction is needed, the Control Box sends a signal to the control valve, raising or lowering the implement until it is on-grade.

The operator always has full control over the system, allowing automatic or manual control. Changes in grade can also be dialed in from the Control Box, as well as many other operational and performance functions.

Getting Acquainted

The System Five has several components: Control Box, Laser Receiver/Trackerjack, and the TM-1 mast or vibration pole.

Control Box

The Control Box (Figure 1-2 on page 1-3) is the operator’s interface to System Five™. After receiving signals from the sensors (Laser Receiver and/or Slope Sensor), the Control Box determines if grade or slope corrections are necessary. If a change in grade or slope is required, the Control Box sends a signal to the valve controlling the implement to raise or lower it, thus maintaining correct grade.
Figure 1-2. Control Box

The Control Box connects to the Laser Receiver and hydraulic valve through electrical cables.

**TM-1 Mast or Vibration Pole**

Depending on your setup, you could have either a TM-1™ Mast or a vibration pole attached to your implement.

- The TM-1 Telescoping Mast allows fast, stable movement for the laser receiver. The height can be adjusted from the Control Box.

- The vibration pole provides a lightweight mount for the laser receiver and utilizes shock isolation and vibration dampening.
**Laser Receiver**

The Laser Receiver (Figure 1-3) is an elevation control sensor that measures and controls the elevation of the implement. When receiving a signal from a rotating laser, the laser receiver sends a signal to the control box through connecting cables.

![Figure 1-3. Laser Receivers](Image)

**Sonic Tracker II**

The Sonic Tracker II™ measures and controls the elevations of the blade, scraper, or other implement. A transducer, located in the bottom of the Sonic Tracker II, generates sound pulses like a speaker and listens for returned echoes like a microphone (Figure 1-4 on page 1-5). The Tracker measures the distance and controls grade from a physical grade reference, such as a curb, stringline, or existing surface.

The Sonic Tracker II attaches to the system through a quick connect cable and attaches to the machine with a single bolt. At the end of the day, remove the Sonic Tracker II for proper storage in the carrying case.
The Blade Slope Sensor (Figure 1-5 on page 1-5) is installed on the machine’s blade and should not be removed, other than for service, and has no manual adjustments.

The Blade Slope Sensor provides precise slope measurements of the cutting edge. The Control Box provides steps to calibrate the sensor. To ensure correct slope, perform a sensor calibration before operating the equipment.
System Five Setup

The System Five has several components that attach to each other using cables. The cables allow communication between the Sensor, the Control Box, and the Hydraulic Valves. When the Sensor detects a change in slope or elevation, it sends a signal to the Control Box, which then sends a pre-programmed, instructive signal to the Hydraulic Valves. Once the valves receive the signal, they raise or lower the implement according to the setup of the Control Box.

After mounting the several System Five components to the implement, the following procedure will help you get started setting up your System Five.

- If using a System Five setup with a TM-1 Mast, see “Setup with TM-1 Mast” on page 1-9.
- If using a System Five setup with a Vibration Pole, see “Setup with Trackerjack and Vibration Pole” on page 1-13.

After setting up your System Five, see:

- “Control Box Usage” on page 2-1 for how to use the Control Box and Performance Menu settings.
- “Laser Setup” on page 3-1 for setting up and checking the laser transmitter.
- “Grading” on page 4-1 for using the System Five while grading.

Figure 1-6 on page 1-7 and Figure 1-7 on page 1-8 show generalized System Five connection diagrams of the tractor and implement components.
Figure 1-6. Typical Laser System Setup with LS-B2 and TM-1 Mast
Figure 1-7. Typical Laser System Setup with LS-B4 and Vibration Pole
Setup with TM-1 Mast

1. If using a TM-1 Mast or vibration pole, bolt it to the implement being controlled. Visually check that the mast/pole is plumb.

**TIP**
Typically, the TM-1 Mast remains bolted to the implement and is removed only for transport or extended storage.

2. Attach the laser receiver to the TM-1 mast or pole (Figure 1-8).

![Figure 1-8. Attaching Laser Receiver to TM-1 Mast](image-url)
3. Connect the coil cord to the laser receiver and TM-1 Mast (Figure 1-9).
4. Attach the cord to the snap hook, then pull it snug and wrap it around the shock mount (Figure 1-10). This ensures that the force of the moving cord is not on the connectors.

Figure 1-10. Attach Coil Cord to Snap Hook and Wrap it Around Shock Mount

5. If needed, check the hydraulic valve connections. The hydraulic valve cable should already be attached to the mast or pole. Depending on your setup, the hydraulic valve will connect to either the Control Box (with the power cable) or the mast/pole.
6. Attach the Control Box to a mounting bracket (Figure 1-11).

![Sample mounting bracket](image)

**Figure 1-11. Mounting Control Box**

7. Connect the cables to the Control Box (Figure 1-12).

![Connecting cables to Control Box](image)

**Figure 1-12. Connecting Cables to Control Box**
Setup with Trackerjack and Vibration Pole

1. If using a vibration pole, bolt it to the blade or implement being controlled. Visually check that the pole is plumb.
2. Connect the cables to the Control Box (Figure 1-12). Then turn on the Control Box.

![Figure 1-13. Connecting Cables to Control Box](image)

3. Attach the Trackerjack to the vibration pole, sliding the wheels into the slots at the bottom of the pole. Attach the coil cable to the Trackerjack™ (Figure 1-14 on page 1-14).
4. Raise the Trackerjack until its magnetic pickup sensor is above the magnet at the bottom of the pole (Figure 1-15). The magnets at the top and bottom of the pole keep the Trackerjack on the pole.

Figure 1-14. Attaching Laser Receiver to Vibration Pole

Figure 1-15. Raise Trackerjack Above Magnet
Care and Maintenance

At the end of the day, performing general maintenance and storing mobile parts will help to keep your System Five in top condition.

- Insert cables into appropriate storage connectors after removing the Control Box.
- Remove the Control Box and the Laser Receiver and dust with a dry or damp non-abrasive, soft cloth.
- Store the various removable components in the carrying case.
- Check for oil leaks in hydraulic assemblies and hoses.

In general, you should follow these guidelines:

- Always clean and thoroughly dry the removable components before storing them in carrying cases. Use a clean, soft cloth moistened with a neutral detergent or water.
- Keep carrying cases clean and dry. Do not leave them open and exposed to the elements.
- Some moisture on the Control Box and its components is acceptable during working conditions. Do not spray water or use high pressure steam cleaner hoses directly on cables and components.
- Use protective connector caps on cables when not using the System Five for a period of time. Water accumulating on the connectors can cause electrical shorts.

Refer to your laser's documentation for care of the laser transmitter and sensor.
The Control Box is the operator’s interface to System Five™. The Control Box receives signals from the sensors (such as the Laser Receiver and/or Slope Sensor), and uses these signals to determine if grade or slope corrections are necessary. If the leveling requires a change in grade or slope, the Control Box sends a signal to the valve, raising or lowering it to the correct height.

Control Box functions provide simple ways to apply settings, change functions, view and record elevation information, and allow automatic or manual control.

This chapter describes:

- The buttons, knobs, and switches on the Control Box.
- How to change settings, access information, and take readings using the various buttons, knobs, and switches.
- The menus available in the Performance Menu.
- How to access, change settings, and apply features using the Performance Menu.
Control Box

The front of the Control Box is made up of buttons, LEDs, an LCD screen, switches, and a knob (Figure 2-1).

1. “LCD Display”
2. Light sensor for grade adjustment arrows
3. Power switch
4. Grade adjustment direction arrows
5. Grade adjustment knob
6. Grade adjustment LEDs
7. Function indicator LEDs
8. Set (Menu) button
9. Elevation offset and Elev/Avg button
10. Slope/Elevation button
11. Survey/Search button
12. Auto/Manual button
13. Jog button
**LCD Display**

The LCD (Figure 2-2) allows the operator to view text and reference settings.

![Figure 2-2. LCD Display](image)

**Light Sensor for Grade Adjustment Arrows**

The light sensor monitors ambient light to increase the intensity of the grade adjustment arrows in bright sunlight and dim the grade arrows for nighttime operation.

The light sensor is located above the power switch.

**Power Switch**

The power switch (Figure 2-3) for the System Five Control Box turns it on and off.

![Figure 2-3. Power Switch](image)
Grade Adjustment Direction Arrows

The grade adjustment arrows are located at the upper left and upper right of the grade adjustment knob.

These two arrows (Figure 2-4) light up in red to indicate the direction you should turn the knob to reach on-grade.

Grade Adjustment Knob

The grade adjustment knob (Figure 2-5) makes measured adjustments to elevation and slope settings, or cycles through menu options.
Grade Adjustment LEDs

The grade adjustment LEDs (Figure 2-6) indicate raise, on-grade, and lower information and corrections.

![Figure 2-6. Grade Adjustment LEDs](image)

Table 2-1 describes Grade Adjustment LED indications.

<table>
<thead>
<tr>
<th>LED Display</th>
<th>LED</th>
<th>Elevation Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slowly blinking, yellow down arrow</td>
<td>▼</td>
<td>Out of range; beyond .28’ above grade</td>
</tr>
<tr>
<td>Solid yellow down arrow</td>
<td>▼</td>
<td>Above grade; between .05’ and .28’</td>
</tr>
<tr>
<td>Blinking yellow down arrow</td>
<td>▼</td>
<td>Above grade; between .02’ and .05’</td>
</tr>
<tr>
<td>Blinking yellow down arrow with green bar</td>
<td>▼</td>
<td>Within .02’ of grade</td>
</tr>
<tr>
<td>Blinking green bar</td>
<td></td>
<td>On grade</td>
</tr>
<tr>
<td>Blinking red up arrow with green bar</td>
<td>▼</td>
<td>Within .02’ of grade</td>
</tr>
<tr>
<td>Blinking red up arrow</td>
<td>▼</td>
<td>Below grade; between .02’ and .05’</td>
</tr>
<tr>
<td>Solid red up arrow</td>
<td>▼</td>
<td>Below grade; between .05’ and .28’</td>
</tr>
<tr>
<td>Slowly blinking red up arrow</td>
<td>▼</td>
<td>Out of range; beyond .28’ above grade</td>
</tr>
</tbody>
</table>
**Function Indicator LEDs**

The function indicator LEDs are located below the jog button:

- **CON** – The box is in Control Mode.
- **SUR** – The box is in Survey Mode.
- **ELEV** – The LCD displays the current elevation.
- **AVG** – The LCD displays the calculated average elevation.

**Set/Menu Button**

The Set/Menu button (Figure 2-7) has two functions:

- **Set Mode** – used to change the reference number viewed on the display to a desired value.
- **Menu Mode** – used to access the performance menu.

**Using the Set Mode**

The Set mode changes the reference number viewed on the display to a desired value. The reference number sets the elevation or slope display number.

1. Press and hold the **Set/Menu** button.
2. Dial in the desired value using the **Grade Adjustment Knob**. Both the Grade Adjustment Arrows and the Double Arrows light up.
3. Release the **Set/Menu** button to save the value.
Using the Menu Mode

The Menu mode assigns menu mode functions, allowing you to set valve offsets, units of measurements, an alarm, deadband, and other useful functions.

See “Performance Menu” on page 2-15 for information on using the menu settings.

Elevation Offset Button and Elev/Avg Button

This button has two functions:

- Control Mode – acts as an Elevation Offset button.
- Survey Mode – acts as an Elevation/Average button.

Using the Elevation Offset Button

The Elevation Offset button toggles the display to the next offset, if two or three different offsets have been set in the Performance Menu.

For example, if the job requires three different elevation settings: one for the “Field” elevation, another 1’ higher than the field setting, and the third, .5’ lower than the field setting:

1. Select three Offsets in the Performance Menu, and return to Control Mode. Dial the Grade Adjustment Knob to set the display to the desired “field” elevation, such as 5.50.
2. Press the Offset button for one second to move to the next Offset. Turn the Grade Adjustment knob to set the display to 6.50, 1 foot higher than the field elevation.

3. Press the Offset button for one second to move to the next Offset. Turn the Grade Adjustment Knob to set the display to 5.00, .50 feet lower than the field elevation.

Each time you press the Offset button for one second, the grade setting moves to the next Offset: 5.50 to 6.50 to 5.00.

To change an elevation setting, turn the Grade Adjustment Knob; changing one setting does not affect other settings.

**Using the Elev/Avg Button**

In Survey Mode, this button toggles the LCD to view the current elevation reference number, view the current calculated average elevation, or clear the average elevation.

**View Current Elevation**

When the current elevation displays (Figure 2-9), the ELEV LED illuminates.
Elevation Offset Button and Elev/Avg Button

**View Average Elevation**

To view the average elevation, press the Elev/Avg button (Figure 2-10 on page 2-9); the AVG LED illuminates.

If no points have been taken, “---” displays on the LCD. See “Using the Survey Mode” on page 2-12 for information on taking points.

**Clear Average Elevation**

To clear the average elevation:

1. Press the ELEV/AVG button to display the average elevation (Figure 2-10).

2. Press the ELEV/AVG button again and hold it for three seconds: a beep sounds and “CLR” displays. After the three seconds, “---” displays, indicating the average has been cleared.
Elevation/Slope Button

The elevation/slope button (Figure 2-8) is used to set the System Five™ for slope or elevation control.

Setting the Elevation Mode

Use Elevation Mode for laser control.

Press the Slope/Elevation button: the green LED next to the Elevation Symbol illuminates.

Setting the Slope Mode

If the Control Box is connected to a slope sensor, the desired cross slope can be dialed in for automatic control.

1. Press the Slope/Elevation button: the yellow LED next to the Cross Slope Symbol illuminates.
2. Turn the Grade Adjustment Knob until you get the desired cross slope.

Search/Survey Button

The search/survey (Figure 2-12) button is used to search for and lock on-grade, or to continuously track a laser beam while surveying the field.
Using the Search Function

Hold the Search/Survey button for one second. The laser receiver searches for an on-grade signal and locks on-grade.

If the laser receiver has an electric mast, press the button a second time to stop the search. Press the button a third time, and the electric mast reverses direction and searches again.

Using the Survey Function

Hold the Search/Survey button for three seconds to enable the Survey mode.

The laser receiver/electric mast continuously tracks the laser beam while surveying the jobsite.

Auto/Manual Button

The auto/manual button (Figure 2-13) has three functions:

- In Control Mode, acts as an auto/manual selection button.
- In Survey Mode, acts as an on/off selection button for recording elevation readings.
- Makes selections in the Performance Menu.
Using the Auto/Manual Mode

Using the Auto/Manual button, the operator can select between Automatic Control or Manual Control.

- Auto control – the control box sends electrical signals to the electric control valve to automatically raise or lower the implement to keep it on-grade.
- Manual control – the operator can view the grade adjustment LEDs, and use the tractor’s manual hydraulic control to raise or lower the implement.

Pressing the Auto button switches the box from Auto to Manual, or from Manual to Auto. When the Control Box is in Auto mode, the Auto button LED illuminates.

If a remote auto/manual button is connected:

1. Press the Control Box Auto button. The Auto LED begins to blink, but the Control Box is still in its current mode.
2. While the Auto LED blinks, use the remote Auto/Manual button to set the Control Box to Auto or Manual. The Auto LED remains steady for automatic control or turns off for manual control.

Using the Survey Mode

When using the Survey mode, the Control Box can record elevation numbers either manually or automatically, and calculate an average elevation.

**Manual Record**

To use the Manual record function, set Record to OFF on the Performance Menu (see “Record” on page 2-35).

Press the Auto button each time you want to record an elevation reading. A beep sounds each time you take a reading.
Auto Record

To use the Auto record function, set Record to ON on the Performance Menu (see “Record” on page 2-35).

Press the Auto button to continuously record elevation readings once per second. A beep sounds each time the Control Box takes a reading.

- Press the Auto button again to pause readings.
- Press the Auto button a third time to restart readings.

Average Elevation

The System Five Control Box can automatically display the average elevation as a survey progresses. While surveying, simply press the ELEV/AVG button to switch between current and average elevations.

Making Selections in the Performance Menu

When using the Performance Menu, use the Auto/Manual button to select settings and functions for the System Five Control Box. See “Performance Menu” on page 2-15 for information on the different menus available.

Jog Button

The jog button (Figure 2-14) activates the hydraulic valve to raise or lower the implement.

Figure 2-14. Jog Button
Determining Timed Valve Output Values

See “Timed Outputs” on page 2-36 for setting timed outputs.

Follow this procedure to determine the time values to set into the Control Box for laser implement control:

1. Set the implement so the cutting edge just rests on the ground.
2. Press and hold the Raise Jog button until the implement raises to the height you prefer, noting how long it takes. Set this time into the Control Box for the Raise Timed-Output.
3. Leaving the implement at this height, press and hold the Lower Jog button until the implement is just above the ground, noting how long it takes. Set this time into the Control Box for the Lower Timed-Output.

The Timed-Output feature can also be used to combine the Auto/Manual function and Jog Raise/Lower function in one button.

Set the Timed-Output to 0.1-second for raise and/or lower.
- Pressing the raise button shifts the system to manual.
- Pressing the lower button shifts the system to auto.

This allows the Timed-Output function to switch to manual when just raising the implement out of a cut, but it will not continue to raise the implement once you release the jog button.

Pressing the Raise Jog Button

For any Timed Outputs value above 0.0 seconds, pressing the raise jog button causes:

1. The beeper to sound.
2. The Control Box to switch to Manual control.
3. The Control Box valve outputs to continue to raise the implement until the total Timed Outputs value expires.
Pressing the Lower Jog Button

For any Timed Outputs value above 0.0 seconds, pressing the lower jog button causes:

1. The beeper to sound.
2. The Control Box to switch to Automatic control.
3. The Control Box valve outputs to continue to lower the implement until the total Timed Outputs value expires.

Once the sensor detects a laser signal, the system returns to normal automatic control.

Performance Menu

Performance menu settings allow the System Five to be modified for operator or performance enhancement. A combination of buttons and the Grade Adjustment Knob control and display menu settings.

NOTICE
For some machine configurations, not all menu selections are accessible.

Table 2-2 describes the Control Box menus.

<table>
<thead>
<tr>
<th>Table 2-2. Performance Menu Settings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Menu</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>Gain (Elevation)</td>
</tr>
<tr>
<td>Gain (Slope)</td>
</tr>
<tr>
<td>Valve Offset</td>
</tr>
</tbody>
</table>
Follow these steps to view and/or change menu settings. See the sections that follow for a description of each menu.

### Table 2-2. Performance Menu Settings (Continued)

<table>
<thead>
<tr>
<th>Menu</th>
<th>LED Symbol</th>
<th>Range</th>
<th>Factory Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Averaging</td>
<td>AVG</td>
<td>1–100</td>
<td>1</td>
</tr>
<tr>
<td>Elevation Deadband</td>
<td>db</td>
<td>1–30 mm (3 mm = .01 ft)</td>
<td>6 mm (.02 ft)</td>
</tr>
<tr>
<td>Slope Deadband</td>
<td>± db</td>
<td>.025%–.75%</td>
<td>0.075%</td>
</tr>
<tr>
<td>Beeper</td>
<td>beep</td>
<td>on/off</td>
<td>off</td>
</tr>
<tr>
<td>Unit</td>
<td>unit</td>
<td>ft, cm</td>
<td>ft</td>
</tr>
<tr>
<td>Test</td>
<td>tst</td>
<td>open, short, pass</td>
<td>no setting</td>
</tr>
<tr>
<td>Set Points</td>
<td>set</td>
<td>1–3</td>
<td>1</td>
</tr>
<tr>
<td>Record</td>
<td>rec</td>
<td>on/off</td>
<td>on</td>
</tr>
<tr>
<td>Timed-Outputs</td>
<td>to</td>
<td>0.0 –10.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>
1. Turn off the power. While holding down the Set/Menu button turn the box back on (Figure 2-15). The Auto LED light and Grade Adjustment Direction Arrows flash.

![Figure 2-15. Setting Control Box to Performance Menu Settings](image)

2. Rotate the **Grade Adjustment Knob** to scroll through the Performance Menu selections (unit, beeper, test, etc.) displayed on the LCD (Figure 2-16).

![Figure 2-16. Scrolling Through Performance Menu Selections](image)

3. Press the **Auto** button to select a menu.
4. Turn the **Grade Adjustment Knob** to view the options available for the menu selection (Figure 2-17).

![Figure 2-17. Scrolling Through Menu Options](image)

5. Press the **Auto** button again to store the value/option (Figure 2-18).

![Figure 2-18. Storing Menu Option](image)

To access other Menu settings, turn the **Grade Adjustment Knob**.

To exit the Performance Menu, press the **Set/Menu** button.
**Gain (Elevation)**

This setting determines the speed at which the System Five™ allows the implement to adjust to a change in grade. The gain can be adjusted from a setting of 1 to 100.

- For faster hydraulic response, increase the gain value.
- For slower hydraulic response, decrease the gain.

The objective is to set the gain so the implement reacts to the change in grade quickly, but without “overshooting” the new elevation.

1. Rotate the **Grade Adjustment Knob** to access the Gain Menu for elevation. Press the **Auto** button to select the Gain (Elevation) (gAn) menu (Figure 2-19).

![Figure 2-19. Selecting Gain (Elevation) Menu](image-url)
2. Turn the **Grade Adjustment Knob** to select the desired value (Figure 2-20).

![Figure 2-20. Selecting Gain Menu Option](image)

3. Press the **Auto** button to store the value and return to the Performance Menu.

4. Rotate the **Grade Adjustment Knob** to access another item on the Performance Menu. Or, press the **Set/Menu** button to exit.

**Gain (Slope Control)**

This setting determines the speed at which the System Five™ allows the implement to adjust to a change in slope. The gain can be adjusted from a setting of 1 to 100.

- For faster hydraulic response, increase the gain value.
- For slower hydraulic response, decrease the gain value.

The objective is to set the gain so the implement reacts to the change in grade quickly, but without “overshooting” the new elevation.
1. Rotate the **Grade Adjustment Knob** to access the Gain Menu for slope control. Press the **Auto** button to select the Gain (Slope Control) (gAn) Menu (Figure 2-21).

![Figure 2-21. Selecting Gain (Slope Control) Menu](image)

2. Turn the **Grade Adjustment Knob** to select the desired value (Figure 2-22).

![Figure 2-22. Selecting Gain Menu Option](image)

3. Press the **Auto** button to store the value and return to the Performance Menu.

4. Rotate the **Grade Adjustment Knob** to access another item on the Performance Menu. Or, press the **Set/Menu** button to exit.
Valve Offset

The Valve Offset is the amount of electrical signal sent to the valve which causes the hydraulic cylinder to just begin to move. If the signal is too small, you will not have fine correction control. Likewise, if the signal is too large, the cylinder will move too much and overshoot on-grade.

1. Rotate the Grade Adjustment Knob to access the Valve Offset menu. Press the Auto button to select the Valve Offset (OFS) menu (Figure 2-23).

![Figure 2-23. Selecting Valve Offset Menu](image)

This automatically activates the value screen for Raise. The Raise Grade Correction Arrow illuminates, and the Control Box begins to send a raise correction signal to the valve.

2. Turn the Grade Adjustment Knob counter clockwise, decreasing the Valve Offset value until the hydraulic cylinder is not moving. Then, slowly rotate the Grade Adjustment Knob clockwise until the hydraulic cylinder just begins to raise (Figure 2-24 on page 2-23).
3. Press the **Auto** button to store the Raise Offset Value (Figure 2-25).

Pressing the **Auto** button also switches the box to Lower Offset. The Lower Grade Correction Arrow illuminates and the Control Box begins to send a lower correction signal to the valve.
4. Turn the **Grade Adjustment Knob** counter clockwise, decreasing the Valve Offset value until the hydraulic cylinder is not moving. Then, slowly rotate the **Grade Adjustment Knob** clockwise until the hydraulic cylinder just begins to lower (Figure 2-26).

![Figure 2-26. Changing Valve Lower Offset Value](image)

5. Press the **Auto** button to store the Lower Offset Value.
6. Press the **Auto** button to return to the Performance Menu.
7. Rotate the **Grade Adjustment Knob** to access another item on the Performance Menu. Or, press the **Set/Menu** button to exit.

**NOTICE**

The jog raise-lower button is always active during valve calibration. If a cylinder bottoms out, you can use the jog button to re-center the cylinder and continue the valve calibration.
Averaging

This setting changes the amount of dampening or filtering applied to the laser receiver measurements. For normal job conditions, a lower value is preferred. When gusty winds cause erratic grade lights, increase the averaging value. The value range is 1 to 100.

1. Rotate the Grade Adjustment Knob to access the Averaging Menu. Press the Auto button to select the Averaging (AVG) menu (Figure 2-27).

![Figure 2-27. Selecting Averaging Menu]
2. Turn the **Grade Adjustment Knob** to select the desired value (Figure 2-28).

![Figure 2-28. Selecting Averaging Menu Option](image)

3. Press the **Auto** button to store the value and return to the Performance Menu.

4. Rotate the **Grade Adjustment Knob** to access another item on the Performance Menu. Or, press the **Set/Menu** button to exit.

**NOTICE**

For bulldozer control, use 1 (no averaging) for the Average setting. Increasing averaging on dozers and some other fast moving, quick reacting machines may cause over-reaction, or waves in the grade.

**Elevation Deadband**

Deadband is the area of the working window that displays as on-grade. While the elevation reference is within the deadband, the machine’s valves remain idle (closed). The wider the deadband (on-grade area), the more an elevation reference can move up or down without initiating a correction.
1. Rotate the **Grade Adjustment Knob** to access the elevation Deadband Menu. Press the **Auto** button to select the Elevation Deadband (db) menu (Figure 2-29).

![Figure 2-29. Selecting Elevation Deadband Menu](image)

2. Turn the **Grade Adjustment Knob** to select the desired value, typically 6mm (0.02’) (Figure 2-30).

![Figure 2-30. Selecting Elevation Deadband Menu Option](image)

**NOTICE**

The numeric value seen on the display is in millimeters (3mm = .01’)

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3. Press the Auto button to store the value and return to the Performance Menu.

4. Rotate the Grade Adjustment Knob to access another item on the Performance Menu. Or, press the Set/Menu button to exit.

Slope Deadband

Deadband is the area of the working window that displays as on-grade. While the slope reference is within the deadband, the machines’s valves remain idle (closed). The wider the deadband (on-grade area), the more a slope reference can move up or down without initiating a correction.

1. Rotate the Grade Adjustment Knob to access the slope Deadband Menu. Press the Auto button to select the Slope Deadband (db) menu (Figure 2-31).

![Figure 2-31. Selecting Slope Deadband Menu](image-url)
2. Turn the **Grade Adjustment Knob** to select the desired value (Figure 2-32).

![Figure 2-32. Selecting Slope Deadband Menu Option](image)

3. Press the **Auto** button to store the value and return to the Performance Menu.

4. Rotate the **Grade Adjustment Knob** to access another item on the Performance Menu. Or, press the **Set/Menu** button to exit.

**Beeper Alarm**

In Automatic Control Mode, the beeper emits a single beep when the laser receiver “loses” the laser beam, such as when dust blocks the laser beam.

In Survey Mode, the beeper beeps each time the Control Box takes a reading to calculate an average.

1. Rotate the **Grade Adjustment Knob** to access the Beeper Alarm Menu. Press the **Auto** button to select the Beeper Alarm (bEP) menu (Figure 2-33 on page 2-30).
2. Turn the **Grade Adjustment Knob** to turn the beeper ON or OFF (Figure 2-34).

3. Press the **Auto** button to store the choice and return to the Performance Menu.

4. Rotate the **Grade Adjustment Knob** to access another item on the Performance Menu. Or, press the **Set/Menu** button to exit.
Units

The Units menu is used to set the display to read elevations and other measurement in feet/hundreds or centimeters.

1. Rotate the Grade Adjustment Knob to access the Units Menu. Press the Auto button to select the Units (unt) menu (Figure 2-35).

![Figure 2-35. Selecting Units Menu](image)

2. Turn the Grade Adjustment Knob to select the desired Units measurement (Figure 2-36).

![Figure 2-36. Selecting Units Menu Option](image)
Table 2-3 describes the available options.

**Table 2-3. Unit Measurement Descriptions**

<table>
<thead>
<tr>
<th>Measurement Display</th>
<th>Description</th>
<th>Numerical Display</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feet</td>
<td>25</td>
<td>25 hundredths of a foot</td>
<td></td>
</tr>
<tr>
<td>Centimeters</td>
<td>2.5</td>
<td>2 1/2 cm (25mm)</td>
<td></td>
</tr>
</tbody>
</table>

3. Press the **Auto** button to store the value and return to the Performance Menu.

4. Rotate the **Grade Adjustment Knob** to access another item on the Performance Menu. Or, press the **Set/Menu** button to exit.

**Test**

This tests the valve for shorts and disconnected valves. The Test menu selection tests the raise valve first, then lower valve.

1. Rotate the **Grade Adjustment Knob** to access the Test Menu. Press the **Auto** button to select the Test (tSt) mode menu (Figure 2-37).

![Figure 2-37. Selecting Test Menu](image)
The raise valves test first. The display reads “Pass” if the raise valves test out OK. If the valves have a problem, the display reads “Open” or “Short”.

2. Press the Auto button to test the lower valves. The display reads “Pass” if the lower valves test out OK. If the valves have a problem, the display reads “Open” or “Short”.

**NOTICE**

This function will always display OPEN when using Danfoss valve output or when connected to a tractor’s existing proportional control valves.

Table 2-4 summarizes the Test solutions.

<table>
<thead>
<tr>
<th>Test Display</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PASS</td>
<td>Good Valve</td>
</tr>
<tr>
<td>OPEN</td>
<td>Valve NOT connected (OR Danfoss valve output being used) (OR connected to existing proportional control valves)</td>
</tr>
<tr>
<td>Short</td>
<td>Valve wires have shorted electronically</td>
</tr>
</tbody>
</table>

3. Press the Auto button to return to the Performance Menu.

4. Rotate the Grade Adjustment Knob to access another item on the Performance Menu. Or, press the Set/Menu button to exit.
Elevation Offsets (Setpoints)

The Offset feature allows the operator to select the number of active elevation offsets or setpoints. Up to three different offsets can be entered.

1. Rotate the Grade Adjustment Knob to access the Elevation Offsets (Setpoints) Menu. Press the Auto button to select the Offsets (SPt) menu (Figure 2-38).

![Figure 2-38. Selecting Elevation Offsets (Setpoints) Menu](image)

2. Rotate the Grade Adjustment Knob to select the desired number of active offsets (1–3).
3. Press the Auto button to return to the Performance Menu.
4. Rotate the Grade Adjustment Knob to access another item on the Performance Menu. Or, press the Set/Menu button to exit.
Record
When using the Survey mode function, the Control Box can record elevation numbers and calculate an average elevation. The Control Box records numbers in two ways:

- Manual Record – The Control Box records an elevation each time you press the Auto button.
- Auto Record – The Control Box continuously records elevation readings once per second after pressing the Auto button. Press the Auto button to “pause” taking readings. Then press the Auto button again to resume Auto Record.

1. Rotate the Grade Adjustment Knob to access the Record Menu. Press the Auto button to select the Record (rEC) menu (Figure 2-39).

![Figure 2-39. Selecting Record Menu](image)

2. Rotate the Grade Adjustment Knob to select ON (auto record) or OFF (manual record).
3. Press the Auto button to return to the Performance Menu.
4. Rotate the Grade Adjustment Knob to access another item on the Performance Menu. Or, press the Set/Menu button to exit.
Timed Outputs

See “Jog Button” on page 2-13 for details about timed outputs.

1. Rotate the Grade Adjustment Knob to access the timed Outputs Menu. Press the Auto button to select the Timed Outputs (to) menu (Figure 2-40).

![Figure 2-40. Selecting Timed Outputs Menu](image)

The Raise light illuminates, and the LCD displays the existing Raise Timed-Output setting (Figure 2-41).

![Figure 2-41. Raise Timed Outputs – Current Setting](image)
2. Rotate the Grade Adjustment Knob to set the desired time in seconds (Figure 2-42). The up jog button arrow light illuminates.

![Figure 2-42. Selecting New Raise Timed Outputs Setting](image)

3. Press the Auto button. The down jog button arrow light illuminates and the LCD displays the existing Lower Timed-Output setting (Figure 2-43).

![Figure 2-43. Lower Timed Outputs – Current Setting](image)
4. Rotate the Grade Adjustment Knob to set the desired time in seconds. The down jog button arrow illuminates (Figure 2-44).

![Figure 2-44. Selecting New Lower Timed Outputs Setting](image)

5. Press the Auto button to set the Timed-Outputs and return to the Performance Menu.

6. Rotate the Grade Adjustment Knob to access another item on the Performance Menu. Or, press the Set/Menu button to exit.
Laser Setup

Using lasers successfully requires attention to three main details:

- Laser placement
- Laser calibration
- Laser axis alignment

If the laser is incorrectly placed, has incorrect calibration, or is misaligned, the cost in time and money to fix any one of these problems can cause delays in completing a project.

NOTICE
Place the laser transmitter as recommended to ensure its availability.

NOTICE
Check the laser calibration daily to ensure correct grade control.

NOTICE
Align the laser to ensure correct slope.

NOTICE
Ensure that the laser grade axis matches the direction of slope on the area to be graded.
Laser Setup

Laser Placement

The physical location of the laser on the jobsite should be outside the actual grading area, if possible. Topcon lasers feature a beam range from 500 to 2000 feet, making placement of the laser outside the grading area easier.

When choosing a location to place the laser transmitter, remember the following two recommendations.

1. Minimize the working distance from the laser.
   
   As the distance from the laser transmitter increases, grade accuracy decreases. The following factors affect grade at long distances:
   
   - Accuracy of individual laser instruments
   - Ground vibration from machinery working near the laser transmitter
   - Calibration error
   - Curvature of the earth
   - Laser movement from blowing wind
   - Atmospheric conditions
   
   For more information, see “Conditions Affecting the Laser Transmitter” on page 3-12.

2. Keep the laser transmitter as low as possible.
   
   Keeping the laser transmitter low, where you can reach it, will make setup and grade changing much easier. The transmitter and laser receiver on the machine will also be more stable. On windy days, you may need to anchor the tripod to keep the laser from moving.

   The laser transmitter does not need to be above the machinery on the job. The benefits of keeping it low far outweigh the momentary loss of the laser beam due to passing equipment.
Small Project Laser Transmitter Placement

On small projects, the laser transmitter can be placed off the working area (Figure 3-1). The working distance from your laser will indicate the type of project (small or large).

Figure 3-1. Laser Transmitter Placement – Small Project
Large Project Laser Transmitter Placement

On larger projects, place the laser in the center of the project to maximize the area you can grade, and minimize the distance from the laser (Figure 3-2). The working distance from your laser will indicate the type of project (large or small).

Figure 3-2. Laser Transmitter Placement – Larger Project

For particularly large projects, you may need to grade one section of the project, then move the laser to finish other sections.
Multiple Pads Laser Transmitter Placement

When grading multiple pads, place the laser in a location that allows you to grade several pads without moving the laser (Figure 3-3).

Hilly Pads Laser Transmitter Placement

When grading on a hilly project, place the transmitter so the elevation of the laser allows for maximum work to be completed before moving before moving it to another location (Figure 3-4).

1. Start at the top of the hill with the laser receiver on the machine at it’s lowest position.
2. Adjust the height of the laser transmitter so the laser receiver picks up the laser.
3. As you work down the hill, raise the laser receiver to adjust for the difference in each pad elevation.
4. If the receiver gets to it’s maximum height, adjust it back down to the lowest position. Then move the transmitter down the hill until the laser receiver picks up the laser beam again, and continue grading.

**Laser Transmitter Calibration**

The laser transmitter is the grade control reference for your project. Check it daily to ensure correct calibration and make adjustments as necessary.

1. Set the laser on a tripod about 150’ to 200’ (45 to 60 meters) from the laser sensor and turn on the laser’s power switch. Confirm that grades are set to 0% slope and the laser is in automatic level mode.
2. Set the laser sensor to “fine correction” mode, if applicable.
3. Raise or lower the sensor to get an on-grade signal (a solid tone) (Figure 3-5). Record or mark the position on the grade rod (X1).
4. Rotate the laser 180° so that side two (the second X axis) points toward the grade rod (Figure 3-6).

5. Raise or lower the sensor to get an on-grade signal (Figure 3-7). Record or mark the position on the grade rod (X2).

---

*See Notice Below Graphic

*If Less Than .02’ No Calibration Necessary*
The calibration error at the distance from the laser to the grade rod is half the amount between the first and second readings.

- If the calibration error is less than .015 ft., no calibration adjustments are necessary.

**NOTICE**

Laser transmitter models have different accuracy specification. Refer to your laser’s documentation for accuracy specifications.

- If a calibration error over .015 ft. has been determined, a field adjustment can be made. See your laser’s documentation for calibration adjustment procedures.

**Laser Axis Alignment**

When setting up the laser to grade a pad or an area with slope, correct laser alignment is critical. The laser transmitter must be aligned so that the laser slope is parallel to the desired slope of your project. Even slight rotation errors can cause significant error in the elevation of the cross slope axis. The steeper the slope, the more error you will have with an incorrectly aligned laser.

**Automatic Alignment**

For lasers with the automatic alignment feature (such as the RT-5Sa), follow these steps to correctly align the laser’s axis:

1. Roughly align a laser’s grade axis to within 10° of the true axis.
2. Position the alignment target:
   - on the true axis up to 328' (100 meters) from the laser,
   - so the “Up” arrow points up, and
   - with the reflective side facing the laser (Figure 3-8 on page 3-9).
Laser Axis Alignment

3. Press **Automatic Alignment** on the laser’s remote control or on the laser’s control panel, then select the grade axis currently facing the alignment target.

4. Press **Enter** to begin auto-alignment.

Refer to your laser’s documentation for further details.

**Manual Alignment**

For lasers with manual alignment, follow these steps to correctly align the axis of your laser.

1. Locate or place two hubs parallel to the slope of the project. The hubs should be approximately 300' apart, or completely across the project on small jobs.

2. Place the laser transmitter over one hub and dial in a 0% slope on both axis.

3. Align the laser by sight, pointing in toward the second hub.

4. Place the grade rod on the second hub and secure it to prevent movement.

The laser transmitter and grade rod should now be positioned so they are parallel to the direction of slope.
5. Set the laser sensor to center the leveling bubble and get an on-grade signal, and lock it into position (Figure 3-9).

6. Dial the slope into the laser transmitter on the axis facing away from the detector. Leave the slope on the axis facing the detector at 0%. If the laser is aligned properly, the grade on the 0% axis will not change at the second hub, and the detector will still have an on-grade signal (Figure 3-10 on page 3-11).

If you do not have an on-grade signal, rotate the laser until you get the on-grade signal.
7. Once you have an on-grade signal, the laser is aligned. Dial in the desired slopes for your project.
Conditions Affecting the Laser Transmitter

The laser transmitter is the grade control reference for the job, and conditions that can affect the transmitter also affect the grade, or quality, of work. Once finish grade control reference points are in place (see “Setting Grade Reference Points” on page 3-14), continue to verify these points throughout the grading process. Succeeding day setups or conditions throughout the day (such as, laser transmitter drift, atmospheric conditions, wind, and other factors) can affect the accuracy of grade being cut or filled. Understanding and identifying these situations will help locate and fix the problem, allowing you to continue grading.

Laser Drift

Laser drift is caused as temperature changes affect the mechanical leveling system of the laser transmitter. Laser transmitters have a level sensor that acts like a precision carpenters level, allowing the transmitter to level to very accurate specifications.

As changes in temperature affect the mechanical leveling system, the laser will re-level to a new position. Although the laser “thinks” this new position is correct, it has induced an error in the grade. Many lasers have a separate level sensor for each axis, so the error may be different in each axis.

If grade increases on one side of the laser and decreases on the other side—or the implement cuts on one end of the project and fills on the other end—the laser beam has drifted and is at an incorrect position (Figure 3-12).

![Figure 3-12. Laser Drift](image-url)
To minimize problems associated with drift, Topcon has developed lasers with leveling systems that eliminate or greatly reduce laser drift. The RT-5S transmitter with its five arc second accuracy and even less repeatability specification, has temperature compensation that automatically adjusts as the outside temperature changes. The RL-H2Sa laser has a five arc second repeatability specification due to the newly developed liquid compensated leveling system that has no mechanical parts to affect the level of the laser beam.

**Atmospheric Laser Bending**

Sometimes, atmospheric conditions can cause the laser beam to bend as it gets farther away from the transmitter. Different atmospheric layers cause this bending, and most frequently occurs in calm-air mornings and evenings in the spring and fall when rapid changes in temperature and humidity occur.

Since temperature and humidity changes also cause drift in some lasers, detecting atmospheric bending as well as drift can help reduce or eliminate grading problems.

Excluding laser drift, if the implement cuts (or fills) on all ends of the field, the laser is bent due to atmospheric bend (Figure 3-13).

![Figure 3-13. Beam Bending Due to Atmospheric Conditions](image)

Atmospheric beam bending can be an inconsistent, increasing error the farther away from the transmitter. The beam bending may be undetectable or minimal at 500'/152m, and may bend down .05'/.015m or more at 1000'/305m from the laser.
Setting Grade Reference Points

Recognizing and measuring errors help to minimize problems and maintain productivity. Once errors are identified, they can be measured against pre-set benchmark hubs or finish grade spots. These grade control reference points can be used throughout the job to verify grade. Set up at least four reference points, one on each axis. On larger projects, use eight benchmarks, two on each axis.

When setting up control points, place the benchmarks 800–1000 feet/305 meters from the transmitter, or near the ends of the field for small projects (Figure 3-14).

Figure 3-14. Set Grade References

If you suspect laser drift, atmospheric bending, or some other problem, use a grade rod on the benchmark hubs, or the implement on the finish grade spots, to measure the error. In most cases and with little or no drift, you can compensate for the small changes that occur from atmospheric bending.

- For 500’/152m to 700’/213m from the laser, there will be little change in grade.
- For 1000’/305m or more, elevation changes will be consistent for a given distance from the transmitter.
Once you have determined the errors and given points on the field, compensate for error due to drift or atmospheric conditions:

- Use elevation offsets in the Control Box to set an elevation for different areas of the field. See “Elevation Offset Button and Elev/Avg Button” on page 2-7 and “Elevation Offsets (Setpoints)” on page 2-34 for information.

- If grading throughout the night, the beam will most likely stay in that position until early morning, or until the wind mixes the layers of air. In this case, set the Control Box to compensate for this error.

**NOTICE**

*Changing grade to match one end of the field to compensate for drift will cause double the error on the opposite side of the laser/field.*

*Therefore, only change grade on one side of the laser if working only on that side.*

- If you measure transmitter drift, make an elevation adjustment to match the reference spot or hub, then work closely to that area. Wait for a time of day to work on other areas of the field when the drift is minimized.
Other Factors Affecting Quality

Along with laser drift due to mechanical and atmospheric drift, wind, dust, fog, and the curvature of the earth affect the accuracy and quality of grading.

Wind

To minimize the affects of wind:

- Secure and stabilize the tripod. Tie the tripod down in gusty wind conditions. In extreme conditions, build a mound and place the laser on a shorter tripod.
- Re-position vertical-mounted screw jacks on laser trailers to be at an angle.
- Four-legged trailers are sometimes difficult to get stable, especially in hard dirt. Wiggle the trailer until all legs are secure and have even pressure on the ground.
- Minimize the working distance from the laser transmitter. Use multiple lasers if needed.
- Increase the Averaging function on the System Five Control Box. If the implement then begins to “porpoise”—i.e., leaving long waves—lower the Averaging setting. See “Averaging” on page 2-25 for information on this setting.

Dust

Dust can block the transmission of the laser beam. A good rule of thumb in dusty conditions: if you can see the transmitter, the receiver can see the beam.

- Work haul paths in a cross-wind direction.
- In extreme dust conditions, try relocating the transmitter up-wind of the work area.
**Fog**

In fog, water droplets diffuse and refract the laser beam. In foggy conditions, the laser receiver will be unable to locate the beam, even if you can see the transmitter.

**Curvature of the Earth**

In theory, a transmitted laser beam will go forever in a straight line; however, the earth is round. Even if the laser has slope dialed in, the effects of a straight beam of light on the round earth are the same. Unless grading at extreme distances, the errors generated from the curvature of the earth are undetectable.

If leveling huge fields, use multiple transmitter setups due to the limitation of the laser distance. Since each laser transmitter levels itself using gravity, the total field distance will not cause compounding errors.

Table 3-1 shows the error’s due to the earth’s curvature at distances from the laser transmitter.

<table>
<thead>
<tr>
<th>Distance From Laser</th>
<th>Curvature of Earth</th>
</tr>
</thead>
<tbody>
<tr>
<td>500' / 152m</td>
<td>.006' / .00183m</td>
</tr>
<tr>
<td>1000' / 305m</td>
<td>.024' / .00732m</td>
</tr>
<tr>
<td>1500' / 457m</td>
<td>.054' / .01646m</td>
</tr>
<tr>
<td>2000' / 610m</td>
<td>.096' / .02926</td>
</tr>
<tr>
<td>2500' / 762m</td>
<td>.150' / .04572m</td>
</tr>
<tr>
<td>3000' / 914m</td>
<td>.215' / .06553m</td>
</tr>
<tr>
<td>4000' / 1219m</td>
<td>.383' / .11674m</td>
</tr>
</tbody>
</table>
Laser Accuracy and Repeatability

The accuracy and repeatability of a laser transmitter are measured in arc seconds. Arc seconds is an angle of measurement used when specifying the accuracy of a laser or other leveling instrument.

A circle is divided into 360°. A degree is divided into 60 arc minutes. An arc minute is divided into 60 arc seconds. Table 3-2 shows how arc seconds relate to elevation at a distance.

**Table 3-2. Arc Seconds vs. Feet/Meters**

<table>
<thead>
<tr>
<th></th>
<th>At 100' /30m</th>
<th>At 500' /152m</th>
<th>At 1000' /305m</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 arc second =</td>
<td>.0005' / .00015m</td>
<td>.0024' / .00073m</td>
<td>.0048' / .00146m</td>
</tr>
<tr>
<td>5 arc seconds =</td>
<td>.0024' / .00073m</td>
<td>.012' / .00366m</td>
<td>.024' / .00732m</td>
</tr>
<tr>
<td>10 arc seconds =</td>
<td>.0048' / .00146m</td>
<td>.024' / .00732m</td>
<td>.048' / .01463m</td>
</tr>
<tr>
<td>15 arc seconds =</td>
<td>.0072' / .00219m</td>
<td>.036' / .01097m</td>
<td>.072' / .02195m</td>
</tr>
</tbody>
</table>
Chapter 4

Grading

With System Five™ and a laser transmitter, you can make faster, fewer, and more consistent cuts to get to grade.

Grading allows the operator to move soil from high spots to low spots, cutting and filling the pad to achieve on-grade. With the use of a laser transmitter and receiver, you can set a specific grade value into the control box, then begin to grade. While you grade, the laser receiver tracks the laser beam, telling the hydraulic valves to move the blade or implement up or down, keeping it on-grade. The result is a smoother and more accurate grading job.

Grading Preparation

Before you begin to grade, you need to:

- Setup the laser transmitter.
- Enter an initial reference elevation.
- Set the cutting edge to grade.
- Set the working reference elevation.

See the following sections for grading preparation procedures.

Laser Transmitter Setup

Setup your rotating laser in the center of the field/pad or in a position within range of the area you intend to grade.

See “Laser Setup” on page 3-1 for general laser transmitter setup and calibration procedures. Refer to your laser’s documentation for more specific setup instructions.
Setting the Cutting Edge to Grade

Setting the cutting edge to grade with a machine control laser dramatically reduces the amount of time needed to set and check grade.

If the laser receiver looks like it rests too low on the mast/pole, raise the laser transmitter. Conversely, if the receiver seems too high on the mast, lower the laser transmitter.

1. Place the grade rod on a reference hub and move the detector up or down to get an on-grade signal (Figure 4-1).

2. Adjust the rod for cut/fill or known elevation of the reference hub (Figure 4-1).

3. Set both sides of the cutting edge on the ground. Press the Survey/Search button to have the receiver search for and lock onto the laser transmitter for an on-grade reading (Figure 4-2 on page 4-3).
4. Press the **Auto/Manual** button to set the System Five in automatic mode. Grade a short pass.

5. Using the grade rod and detector, check the grade cut behind the machine (Figure 4-3).

6. Raise or lower the laser receiver as needed to cut the correct grade, then begin grading the pad.
**Setting the Elevation Reference Number**

After using the grade rod to verify grade, set the Control Box display to reference “finish grade”. Typically, the reference hubs on the jobsite provide either a true elevation reference or a cut/fill value for the graded area. The Control Box can be set to read either the true elevation number or a cut/fill value.

**Use a True Elevation Reference Number**

Typically, you grade flat pads or dead level surfaces to a true or known elevation. After making a pass in automatic mode and verifying the grade using the grade rod, set that number into the display. For example, if the grade is cut at a known elevation of 325.65 feet, set the display to read 5.65.

1. Press and hold the **Set/Menu** button.
2. Dial in the desired value using the **Grade Adjustment Knob** (e.g., 5.65). Both the Grade Correction Indicator Lights and the Double Arrows light up.
3. Release the **Set/Menu** button to save the elevation reference value.

After setting the display, turn the Grade Adjustment Knob to the desired finished pad elevation and switch to automatic control. System Five will control the cutting edge to grade the pad to the desired elevation. This works well when grading multiple pads at different elevations.

**Use a Cut/Fill Value (0.00 Grade Reference)**

Jobs with sloped surfaces typically use a cut/fill value, or 0.00 grade reference; however, flat pads can also use a zero value. After making a pass in automatic control and verifying the cut/fill amount using the grade rod, set that cut or fill number into the Control Box. For example, if the cutting edge is .15 feet above finish grade, set the display to read .15 feet.
1. Press and hold the Set/Menu button.
2. Dial in the desired value using the Grade Adjustment Knob (e.g., 0.15). Both the Grade Correction Indicator Lights and the Double Arrows light up.
3. Release the Set/Menu button to save the elevation reference value.

After setting the display, turn the Grade Adjustment Knob to 0.00 and switch to automatic control. System Five will control the cutting edge to grade the pad to the desired finish grade.

**Use Multiple Elevation Settings**

The Control Box can be set for jobs with multiple elevation settings, or offsets, from one pass to another. You can set up to three different elevation offsets using the elevation offset switch and the performance menu. For example, if the job requires three different pad elevation settings, Pad #1, Pad #2 and Pad #3, set three different offsets/references.

1. In the Performance Menu, rotate the Grade Adjustment Knob to access the Setpoints (SPt) menu, and press the Auto button. See “Performance Menu” on page 2-15 and/or “Elevation Offsets (Setpoints)” on page 2-34 for information on using the Performance and Setpoints menus.
2. Rotate the Grade Adjustment Knob to select the number of offsets, from one to three, required for the job (e.g., 3).
3. Press the Auto button to save the selection, then the Set/Menu button to return to Control Mode.
4. Dial the Grade Adjustment Knob to set the display to the first desired pad elevation (for example, 5.50).
5. Press the Offset button for one second, to save the first offset/reference value and move to the next offset.
6. Repeat steps four and five until the desired number of offsets/references have been set (for example, 6.50 and 5.00).

Each time you press the **Offset** button for one second, the grade reference setting moves to the next offset, or elevation reference (for example, 5.50 to 6.50 to 5.00).

To change an elevation setting, turn the Grade Adjustment Knob; changing one setting will not effect other settings.

**Grading with the System Five**

Once the laser transmitter and Control Box have been set up, and the elevation reference entered or selected, begin grading passes.

1. With the laser receiver and cutting edge on-grade, press the **Auto/Manual** button to set the Control Box to Manual Control Mode.

2. Grade for several feet, then press the **Auto/Manual** button to set the Control Box to Automatic Control Mode. The Auto LED illuminates.

3. In the first 50 feet or so of grading, check the grade several times to make grade adjustments as necessary and/or ensure correct grade.

Even if the pass is off a couple of hundredths, it will be consistently off those hundredths. Therefore, dial in a smaller cut amount on the first pass to determine the grading accuracy of the setup. Then, you can make grade adjustments as necessary to achieve the desired grade.
Troubleshooting

In general, as long as you follow the maintenance and safety instructions provided in this manual, you should have few problems with your System Five™ Control Box. This chapter will help you diagnose and solve some common problems you may encounter with your Control Box.

Before contacting your local Topcon Distributor, try the following:

- Check that all cables are securely and properly connected to the various components of the System Five (control box, TM-1 mast, laser receiver, valves, sensor, etc.).
- Disconnect cables and inspect them for damage or contamination. Clean all connections with an electrical contact cleaner.
## Control Box Problems

This section lists possible System Five Control Box problems you may encounter. If you still have problems after trying the solutions listed here, contact your local Topcon Distributor.

<table>
<thead>
<tr>
<th>Problem</th>
<th>The Control Box LCD does not display.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Causes</td>
<td>Solutions</td>
</tr>
<tr>
<td>The Control Box does not have power.</td>
<td>Check that the machine has power.</td>
</tr>
<tr>
<td></td>
<td>Check the power cable fuse. Replace if necessary.</td>
</tr>
<tr>
<td></td>
<td>Check that all cables are properly and securely connected to the System Five™ Control Box.</td>
</tr>
<tr>
<td></td>
<td>Disconnect cables and inspect them for damage or contamination. Clean all connections with an electrical contact cleaner.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Problem</th>
<th>Control Box LCD displays “Error”.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Causes</td>
<td>Solutions</td>
</tr>
<tr>
<td>The Control Box cannot communicate with the laser receiver.</td>
<td>When turning on the Control Box, watch the lights on the laser receiver. The lights should flash, indicating the Receiver has power.</td>
</tr>
<tr>
<td></td>
<td>Check that all cable are properly and securely connected.</td>
</tr>
<tr>
<td></td>
<td>Check and/or clean all cables as described on page 5-1.</td>
</tr>
</tbody>
</table>
**Problem**
Grade lights flash high and low and will not stay On-Grade.

<table>
<thead>
<tr>
<th>Causes</th>
<th>Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>If problem is only in automatic mode, then hydraulic Performance Settings are incorrect.</td>
<td>Valve Offsets are incorrect. See below. Check if the Gain setting is too high. Reduce the Gain setting as necessary. See “Gain (Elevation)” on page 2-19 or “Gain (Slope Control)” on page 2-20.</td>
</tr>
<tr>
<td>If problem is also in manual mode, then...</td>
<td>The laser transmitter is unstable, secure the laser. Check that the Deadband in Performance Menu is not less than 6mm. See “Elevation Deadband” on page 2-26 or “Slope Deadband” on page 2-28. Increase the Averaging setting using the Performance Menu. See “Averaging” on page 2-25.</td>
</tr>
</tbody>
</table>

**Problem**
The valve is driving the hydraulic cylinder too far and overshooting grade.

<table>
<thead>
<tr>
<th>Causes</th>
<th>Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valve Offsets in Control Box are set too high.</td>
<td>Lower the Valve Offset value until the sensor no longer overshoots grade. See “Valve Offset” on page 2-22 for more information. For Servo and Solenoid valves, lower the value by 2 to 5 numbers, then check the hydraulic performance. For Proportional valves, lower the value by 10 to 15 numbers, then check hydraulic performances.</td>
</tr>
</tbody>
</table>
### Problem
The valve will not drive the hydraulic cylinder far enough to get the sensor On-Grade.

<table>
<thead>
<tr>
<th>Causes</th>
<th>Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valve offsets in Control Box are set too low.</td>
<td>Raise the Valve Offset value until the sensor is driven to grade. See “Valve Offset” on page 2-22 for more information. For Servo and Solenoid valves raise the value by 2 to 5 numbers, then check hydraulic performance. For Proportional valves raise the value by 10 to 15 numbers, then check hydraulic performance.</td>
</tr>
</tbody>
</table>
Appendix A

Safety Precautions

It is your responsibility to be completely familiar with the cautions described in this manual. These precautions advise against the use of specific methods or procedures which can result in personal injury, damage to the equipment, or unsafe operating conditions. Remember, most accidents are caused by failure to observe basic safety precautions.

1. Use extreme caution on the jobsite. Working around heavy equipment can be dangerous.
2. The implement blade and rippers should be grounded before working on or around the machine.
3. Do not attach Topcon components while the engine is running.
4. Protect yourself at all times and wear protective clothing when working on or near hydraulic lines. Hydraulic lines can be under extreme pressure, even when the machine is off.

Topcon cannot anticipate all possible circumstances that could result in a hazard. The warnings contained herein, therefore, are not all inclusive. If you use a tool, procedure, work or operating method other than those Topcon recommends, ensure the safety of yourself and those around you before continuing.
NOTICE
Disconnect all Topcon system electrical cables prior to welding on the machine.

NOTICE
When operating in rainy weather or in wet conditions, the Control Box and cables must be thoroughly dried BEFORE placing them in the carrying case at the end of the day.

NOTICE
Keep the carrying case dry at all times. DO NOT allow moisture to get inside the case. Moisture trapped in the case can adversely affect components.

CAUTION
DO NOT stare into the laser beam or view the beam directly with optical equipment.

WARNING
Relieve all pressure in the hydraulic lines before disconnecting or removing any lines, fittings or related components. If injury does occur, seek medical assistance immediately.
WARNING
Do not weld near hydraulic lines or on any equipment when in operation.

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

WARNING
Be aware of overhead power and telephone lines. Do not drive under power and telephone lines with the mast/pole raised.
Limited Warranty

Electronic and Mechanical Components

TOPCON warrants that the electronic components manufactured by TOPCON shall be free of defects in materials and workmanship for a period of one year from the original date of shipment to the dealer. TOPCON warrants that all valves, hoses, cables and mechanical parts manufactured by TOPCON shall be free of defects in materials and workmanship for a period of 90 days from the date of installation.

Return and Repair

During the respective warranty periods, any of the above items found defective may be shipped to TOPCON for repair. TOPCON will promptly repair the defective item at no charge, and ship it back to you. Calibration of components, labor and travel expenses incurred for in-field removal and replacement of components are not covered under this warranty policy. Damage to components due to negligence, abuse or improper use is NOT covered under this warranty.

Warranty Disclaimer

The above warranties are in lieu of all other warranties, whether expressed or implied, including all warranties of merchantability, or fitness for a particular purpose. In no event will Topcon Laser Systems, Inc. or its Representative be liable for lost profits or other
consequential damages arising from the purchase or use of TOPCON’s components or any performance hereunder or any claims of negligence, even if TOPCON has been advised of the possibility of such damages.

Service assistance can be provided by contacting your local TOPCON dealer or by calling the Corporate Service Center.

Phone: (800) 443-4567
8 a.m. to 5 p.m. Pacific Time
Monday through Friday
FAX: (925) 460-1329

Travel charges will be applied for any on-site service whether warranty or non-warranty in nature.
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