TOPCON

Wheel Loader 3D-MC

SYNERGY POSITIONING SYSTEMS

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Installation and Calibration Manual

Wheel Loader
3D-MC
Installation and Calibration Manual

Part Number 7010-1006
Revision B

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Manual Conventions

This manual uses the following conventions:

Convention	Description	Example
Bold	Menu, or drop-down menu selection	**File > Exit** (Click the **File** menu and click **Exit**)
	Name of a dialog box or screen	From the **Connection** screen...
	Button or key commands	Click **Finish**.
`Mono`	User supplied text or variable	Type `guest`, and click **Enter.**
Italic	Reference to another manual or help document	Refer to the *Topcon Reference Manual.*

 **NOTE**	Further information to note about system configuration, maintenance, or setup.
 **NOTICE**	Supplementary information that can have an adverse affect on system operation, system performance, data integrity, or measurements.
 **CAUTION**	Notification that an action has the potential to result in minor personal injury, system damage, loss of data, or loss of warranty.
 **WARNING**	Notification that an action has the potential to result in personal injury or property damage.
 **DANGER**	Notification that an action has the potential to result in severe personal injury or death.

Introduction

This manual describes the installation and calibration of the Wheel Loader system for 3D-MC applications.

When used with two Topcon GNSS Antennas and a MC-i4 Controller to provide positioning and heading information, the three tilt sensors accurately measure the gravity-referenced angles of the Wheel Loader's body, boom, and bucket. This information is sent to the GX-55/GX-75 Control Box to provide precise 3D guidance. Each sensor is configured and calibrated for its specific location on the Wheel Loader.

System Components—Hardware and Software

Table 1-1 lists the hardware and software components of the Wheel Loader system.

Hardware	Software
TS-i3 tilt sensors (Body, Boom, Attachment/Bucket)	3D-MC® Software Interface
GX-55/GX75 touchscreen display	MCXCONFIG
MC-i4 GNSS machine control receiver	
Topcon GNSS Antenna	

Table 1-1. Wheel Loader System Components

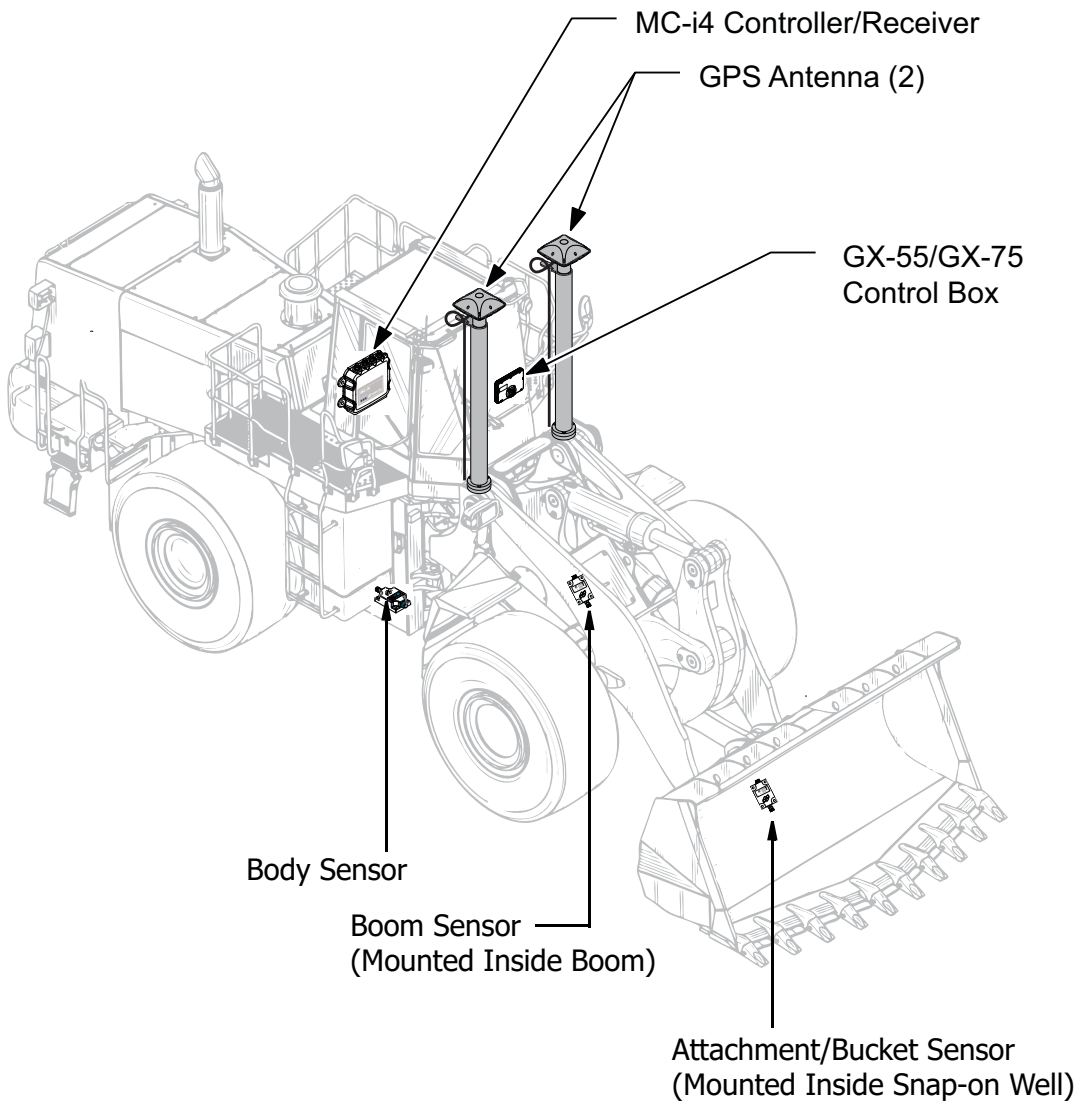

Figure 1-1: Wheel Loader System Components—Receiver, Antenna, Control Box and Sensors

The **TS-i3 Boom Sensor** is mounted on the inside of the **Boom**.

The **TS-i3 Attachment/Bucket Sensor** is mounted on the inside of the **Snap-on Well**.

The **TS-i3d Body Sensor** is mounted on the body of the Wheel Loader.

Sensor Angles

Sitting in the Cab facing forward, the Sensor Angles are 0° (straight ahead—horizontal), +90° (straight up—vertical), and -90° straight down, see Figure 1-2.

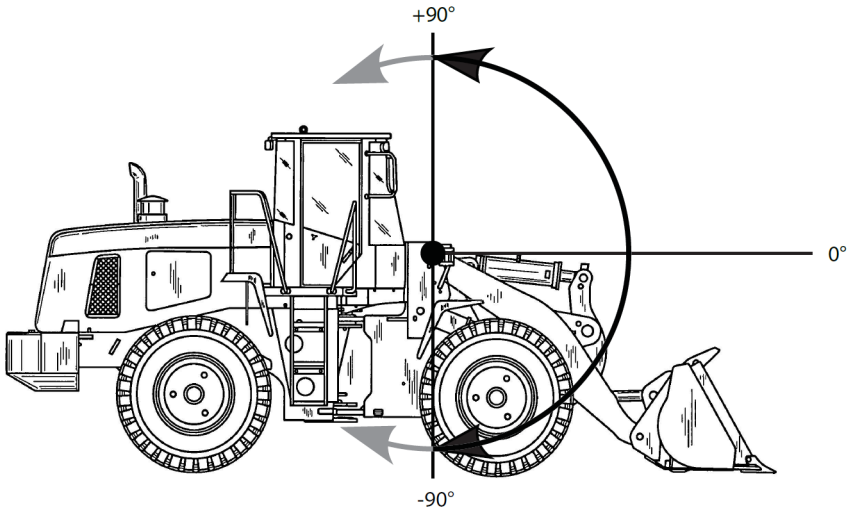

Figure 1-2: *Angle Convention Used for Boom, Body, and Attachment (Bucket) Sensors*

Basic Cable Connections

Figure 1-3 shows the basic cabling connections for the Wheel Loader system. When installing hardware components, use the Topcon supplied fuse or fused power from the Wheel Loader.

CAUTION	Connect the System ground to the frame side of the Ground Disconnect Switch, do not connect the ground directly to the Wheel Loader's Battery Terminal.

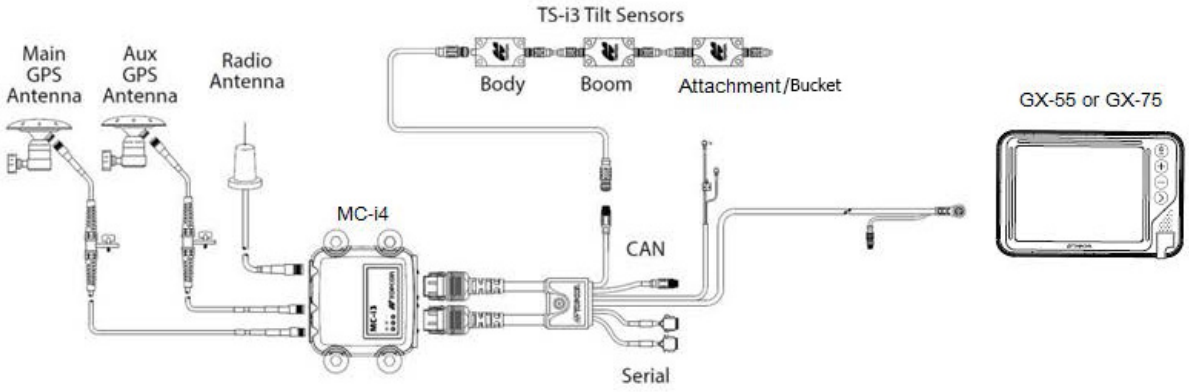

Figure 1-3: Basic Cable Connections for the Wheel Loader System

Tilt Sensor Installation

This chapter describes installation of the TS-i3 sensors onto the body, boom, and attachment/bucket of the wheel loader.

TS-i3 Sensors

NOTE When mounting the tilt sensors, begin with the **Attachment/Bucket** sensor to help simplify cable routing.

Each TS-i3 sensor contains a single or dual axis sensor element, and each sensor will be different depending on where they are mounted. Sensors mounted on the boom and attachment are **single axis** type, and are only mounted in a left or right orientation. The sensor mounted on the body is a **dual axis** type, and is mounted only with a flat orientation with the label up.

NOTE The **Dual Axis** TS-i3 sensor is labeled **TS-i3d**.

When installing the sensors, ensure that they are mounted parallel to the axis being measured (See Figure 2-1 below). Locate surfaces that protect the sensor from physical damage and are convenient for cable routing. When the position of the implement is at zero degrees (horizontal), make a note of the direction of the arrow marker on the serial label (located on the top of the sensor). This direction is needed during calibration. The calibration process uses 3D-MC to enter direction, orientation, and other sensor variables.

TS-i3 Sensor Orientation

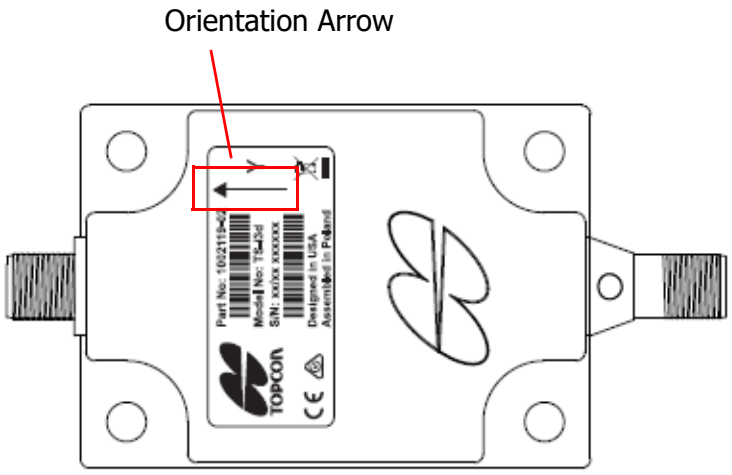

Figure 2-1: TS-i3 Sensor Orientation

NOTE Mount each tilt sensor within +/- 20° of the pivot centerline. Although this does not ensure system performance, squaring the sensors to each part of the machine makes for a cleaner looking installation.

NOTICE Tilt sensor orientation is determined when the **implement** is horizontal (0°). The orientation of each tilt sensor is entered in 3D-MC.

NOTICE Install **Boom** and **Attachment/Bucket** sensors with their serial numbers in ascending or descending order.

NOTICE When entering sensor information, make note of each sensor's serial number and its orientation. TS-i3 sensor orientation for **Boom** and **Bucket** (also known as the Attachment sensor) is only left or right.

Attachment/Bucket Sensor Installation

NOTICE

CAN Termination
To ensure proper communication between the sensors and the Display box, the last sensor physically connected must use the hard terminator provided with the Wheel Loader systems. This hard terminator connects to the **Bucket** sensor

The **Attachment/Bucket** sensor is the most challenging sensor to correctly mount—and to keep the sensor and cables safely protected from damage.

CAUTION Fabrication of a sensor guard and cable protection is recommended to minimize damage. Because this varies widely, such specific protection is not included in the Topcon kit and must be supplied by the installer.

Non Quick Release Attachment/Bucket Sensor Installation

The recommended location for the **TS-i3 Attachment/Bucket Sensor** is on the inside of the **Bucket Snap-on Well**.

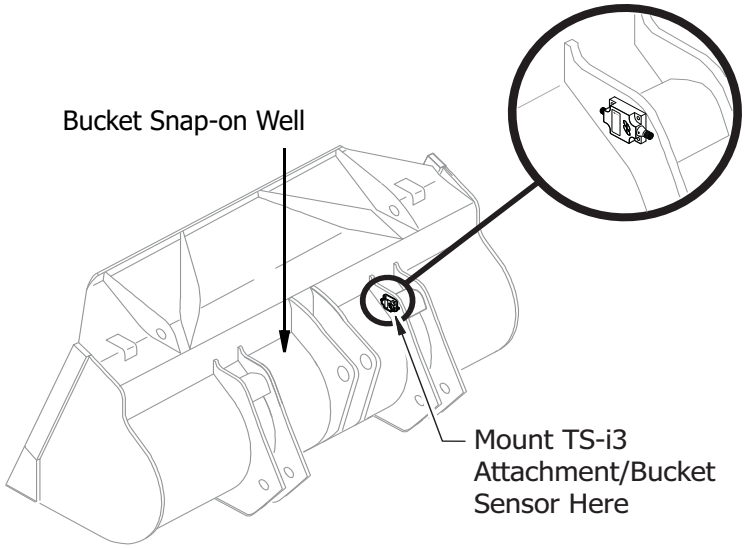

Figure 2-2: Recommended Placement of TS-i3 Attachment/Bucket Sensor

Quick Release Attachment/Bucket Sensor Installation

When using a Quick Release Wheel Loader Bucket Assembly the recommended mounting location for the **TS-i3** sensor is as shown in Figure 2-3.

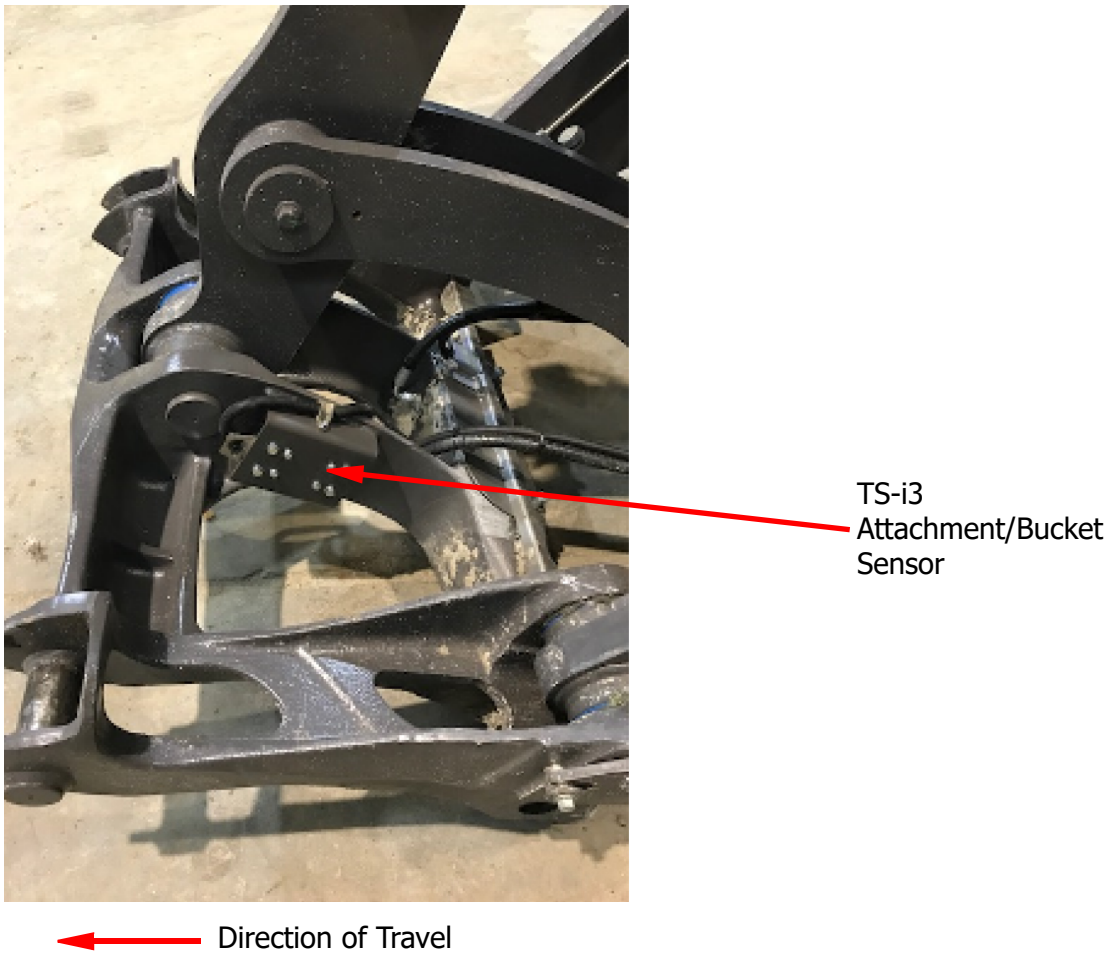

Figure 2-3: Mounting Location for TS-i3 Sensor—When Using a Quick Release Wheel Loader Bucket Assembly

Boom Sensor Installation

Weld or bolt the **TS-i3** Boom sensor onto the inside of the Boom with the with the arrow facing forward in the direction of travel.

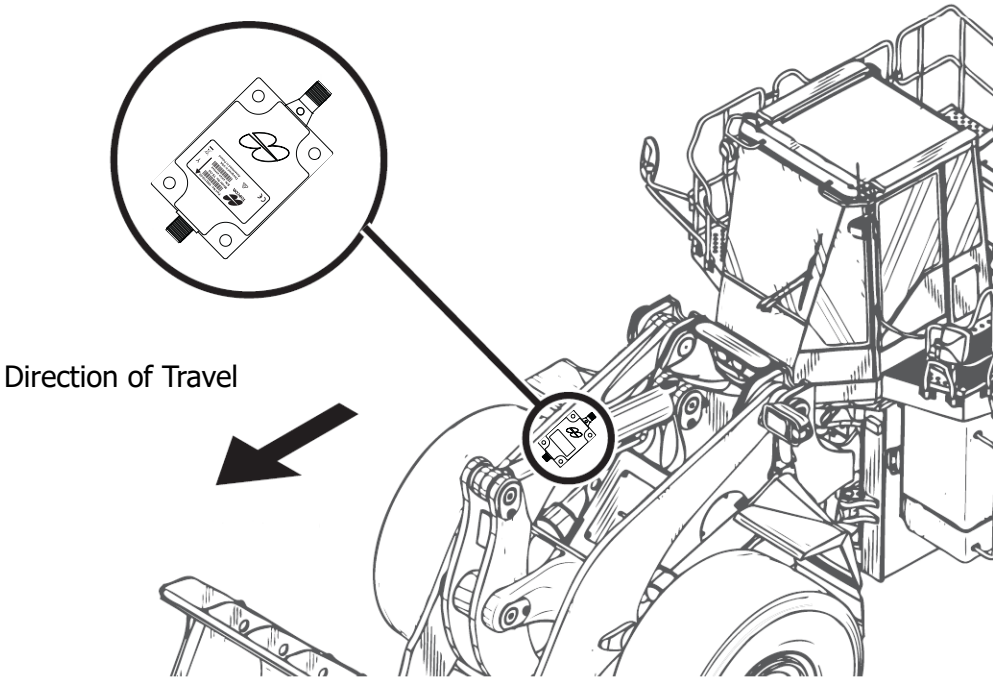

Figure 2-4: Boom Sensor Location

Body Sensor Installation

NOTICE For this installation ensure that the **Body** sensor is a **Dual Axis TS-i3d** sensor.

Mount the **Dual Axis TS-i3d** sensor to the front frame of the Wheel Loader. Ensure that the sensor is squared to the Wheel Loader. Weld or bolt the Body Sensor so that the sensor is flat.

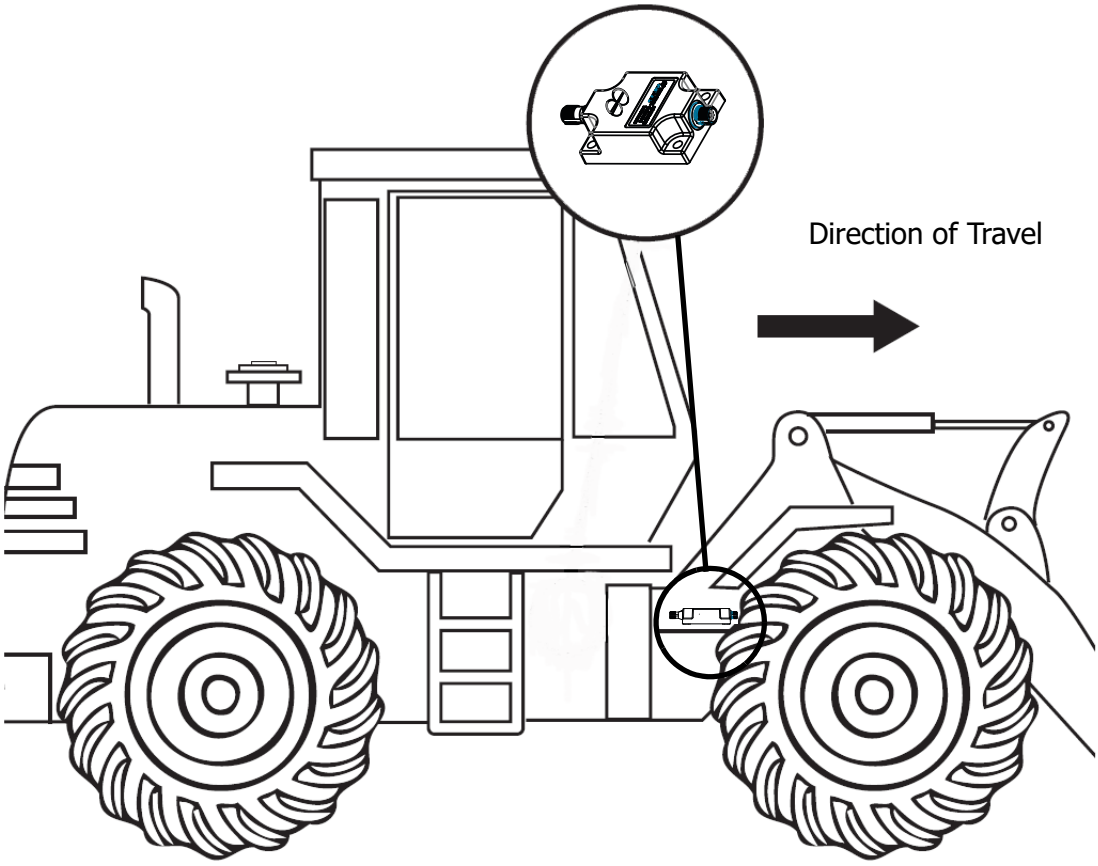

Figure 2-5: Body Sensor Wheel Loader Installation

GNSS Antenna, Mount, and Mast Installation

1. Weld the **Antenna Mast Weld Mount** to top of the Front Lamp Protection plate (Figure 2-8).

NOTE Different Wheel Loaders may require fabrication of a unique mounting surface for the **Antenna Mask Mount**. Ensure that the top of the antenna is flush or slightly above the Cab roof when mounted.

2. Repeat Step 1 on the opposite side of the Wheel Loader.

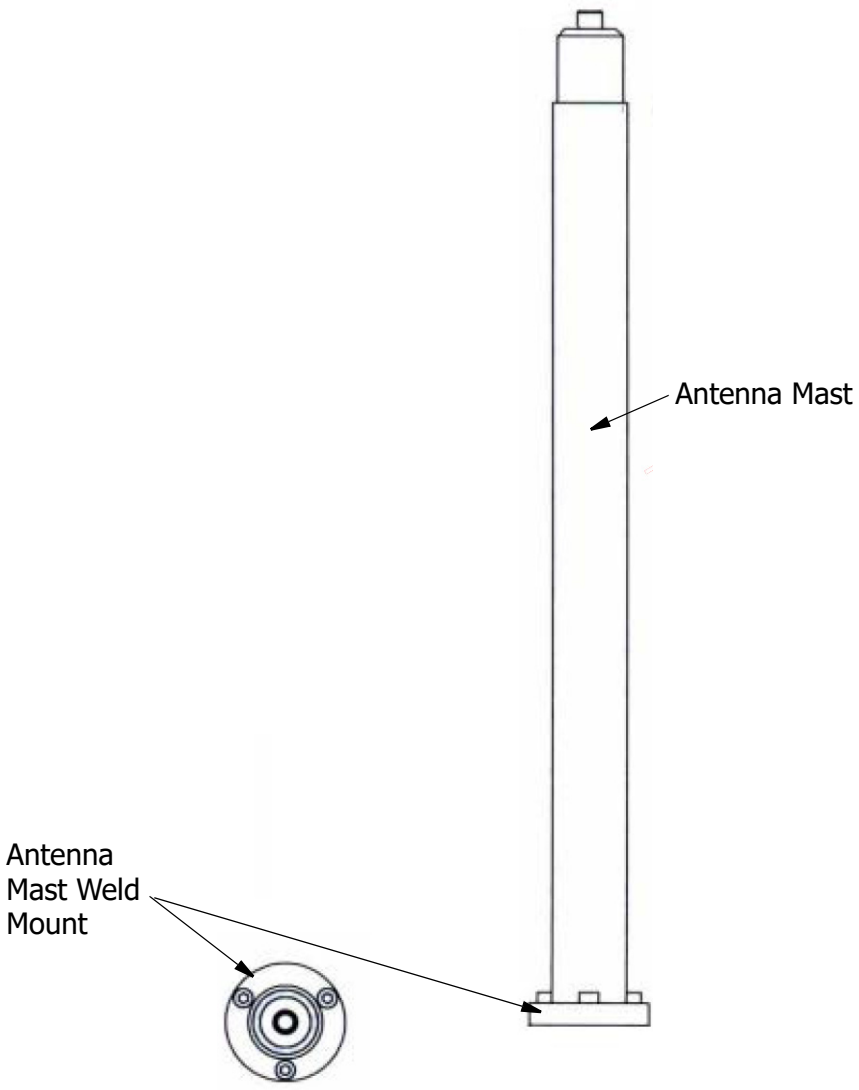

Figure 2-6: Antenna Mast and Mast Weld Mount

3. Install the Antenna Mast.

4. Install the **Strain Relief Bracket**. Remove the two small **Bolts** and route the **GNSS Antenna Cable** through the **Strain Relief Bracket** (Figure 2-7).

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NOTE Ensure enough cable is routed through the bracket, so that the cable can be looped over and threaded into the bracket if or when the antenna is removed from the Wheel Loader (Figure 2-7).

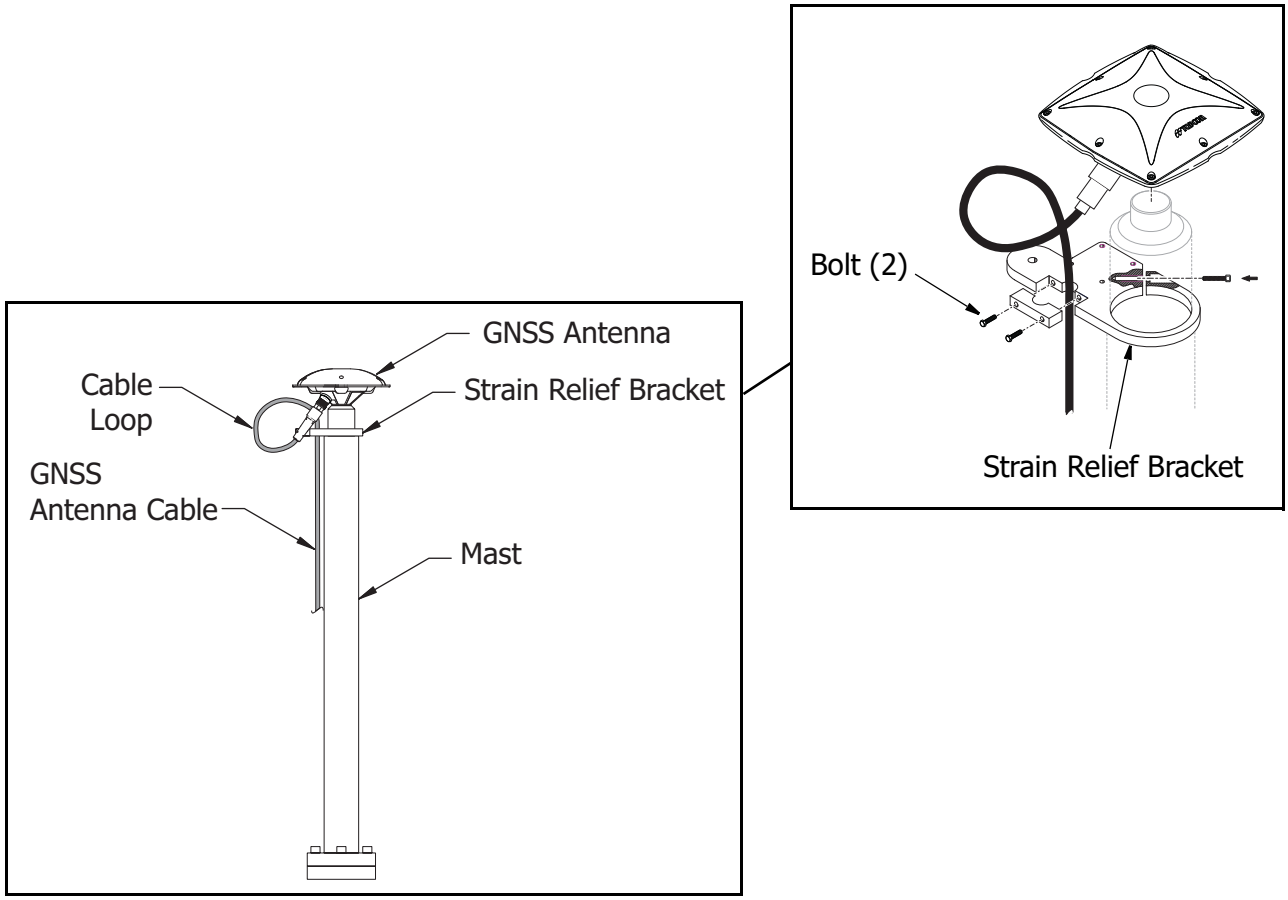


Figure 2-7: Installing the Strain Relief Bracket

5. Repeat steps 3 and 4 for the second antenna mast.

6. Install the two GNSS antennae.

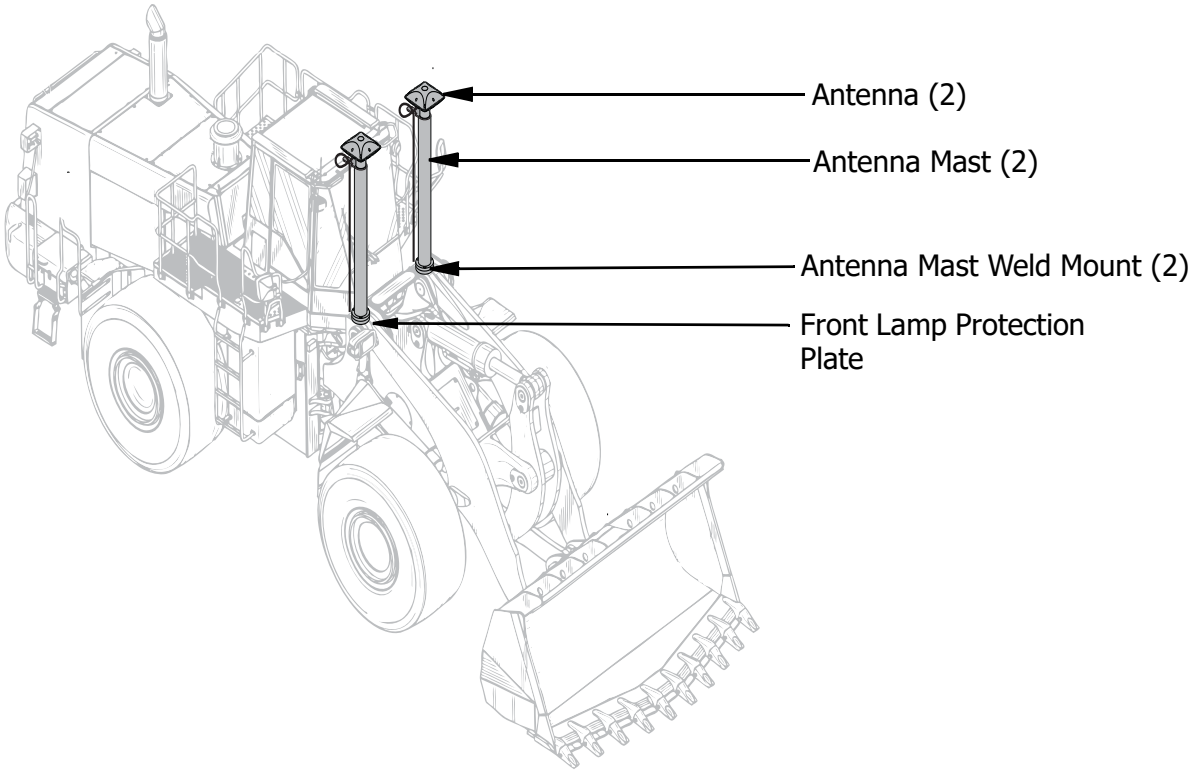


Figure 2-8: GNSS Antenna, Mast, Weld Mounts, and Front Lamp Protection Plate—Installed on the Wheel Loader

Machine Setup and Configuration

Entering Sensor Information

NOTE Topcon recommends starting with a **new** machine configuration file in order to reduce potential machine configuration file issues.

Taking Machine Measurements

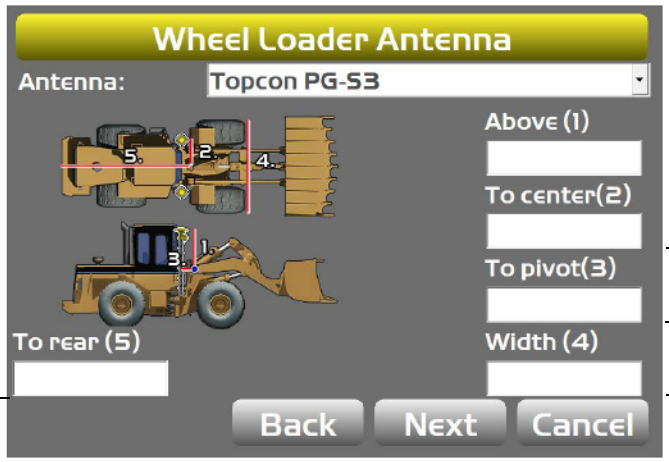
Before taking machine measurements, note the following:

- Check the TS-i3 sensor's serial numbers before installing. The last two digits of the serial number determine the sensor CAN address, and must be unique to each machine.
  - For example, sensor serial number 0302 and 0402 will have the same CAN Termination address ("02"), causing communication errors.
- A sensor's **serial number ending in 00 is considered a special CAN identifier**, and will be identified as **01** in 3D-MC software. Therefore, if you have a sensor with **00** and a sensor with **01**, there will be some confusion in 3D-MC software.
- Accurately measure and enter the machine dimensions into the 3D-MC machine builder. Write your measurements on the lines at the side of the following screen captures (Figure 3-1).

NOTICE Incorrect measurements and/or data entry errors have a direct affect on excavating accuracy. Measure twice and verify your data entry to ensure accuracy.

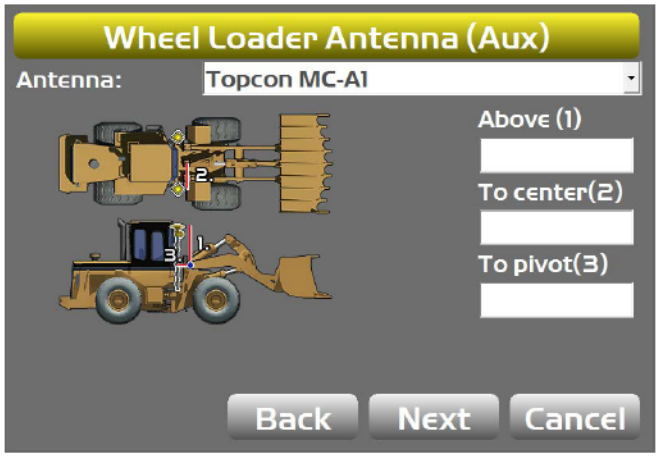
GNSS

Record Wheel Loader Information below:



Record Wheel Loader Information below:

GNSS AUX



Body and Boom

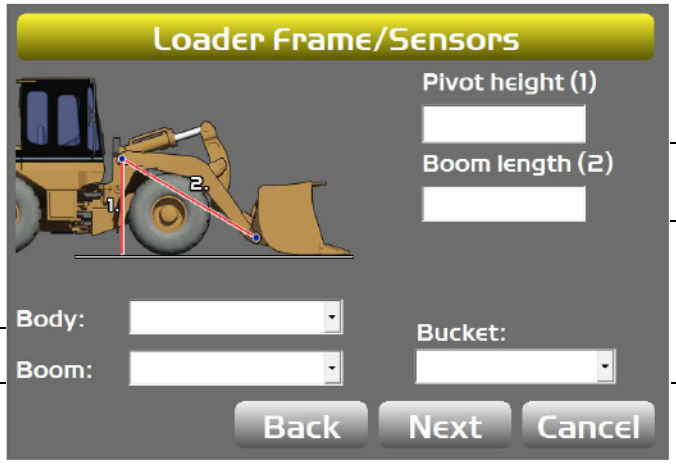
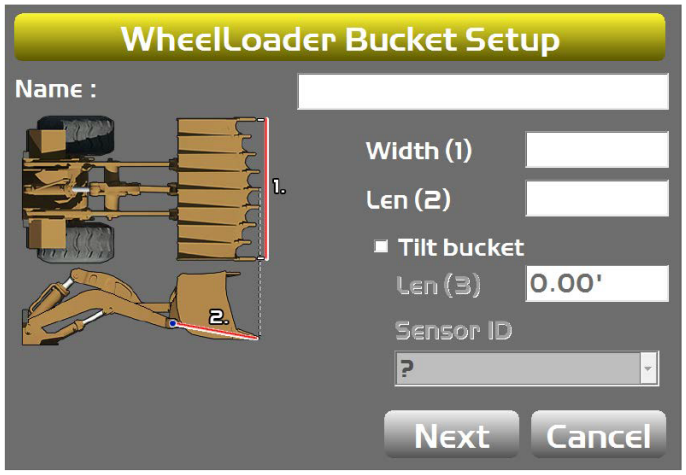


Figure 3-1: GNSS, GNSS Aux, Body and Boom Machine Measurements

NOTE Make a copy of this page. Use this page to record the GNSS Wheel Loader Antenna, GNSS Aux Wheel Loader Antenna, Body, and Boom Loader information for your Wheel Loader.

Record Wheel Loader Information below:

Bucket



Tilt Bucket

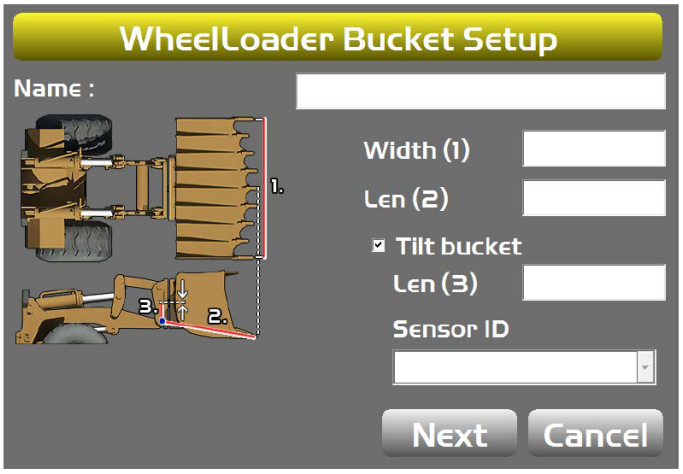


Figure 3-2: Bucket and Tilt Bucket Measurements

NOTE Make a copy of this page. Use this page to record Wheel Loader Bucket and Tilt Bucket Setup information for your Wheel Loader.

Entering Sensor Information

Power up the system and allow several minutes for the 3D-MC software to detect the sensors.

Before calibrating the sensors on the excavator systems, set up each sensor in the 3D-MC Software Interface. You will need the following information:

- the last two digits of the sensor's serial number
- the physical orientation of the sensor mounting

Step 1: Configure the Machine File and the Wheel Loader options.

1. In 3D-MC, tap Topcon Menu Button—Control Machine setup.
2. Select a current machine file and tap Edit, or tap New to create a new machine file.
3. On the **Configuration name/type** screen, enter or select the appropriate data as needed (Figure 3-3).

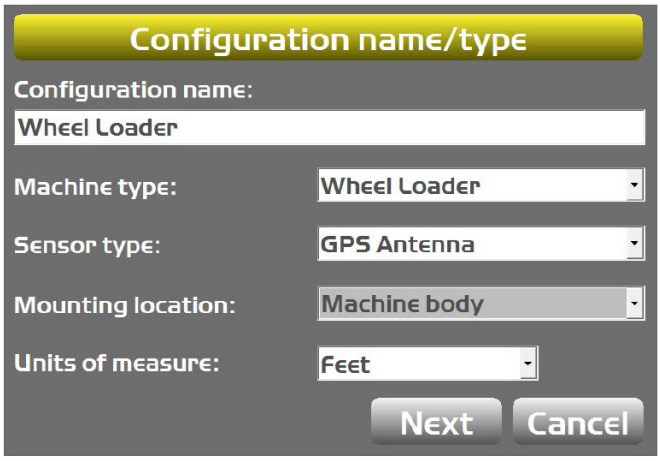


Figure 3-3: Configuration Name and Type

4. Tap **Next** to navigate to the **Wheel Loader Options** screen (Figure 3-3).
5. Select **MC-i3/MC-i4** as the **Position Input** (Figure 3-4).

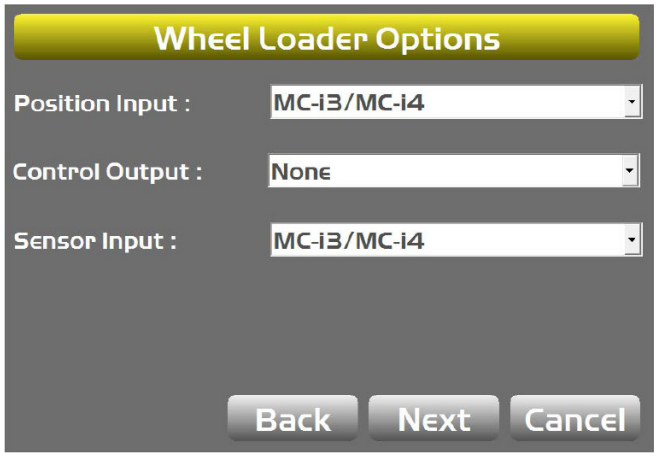


Figure 3-4: Wheel Loader Options

6. Select **MC-i3/MC-i4** for **Sensor Input** (Figure 3-4).

7. Tap **Next** to navigate to the **Wheel Loader Antenna** screen, and select/enter the appropriate values as needed.

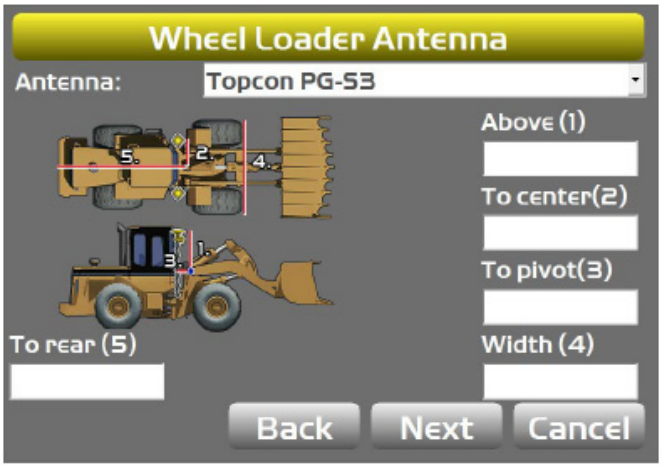


Figure 3-5: Wheel Loader Antenna

8. Tap **Next** to navigate to the **Wheel Loader Antenna (Aux)** screen, and select/enter the appropriate values as needed (Figure 3-5).

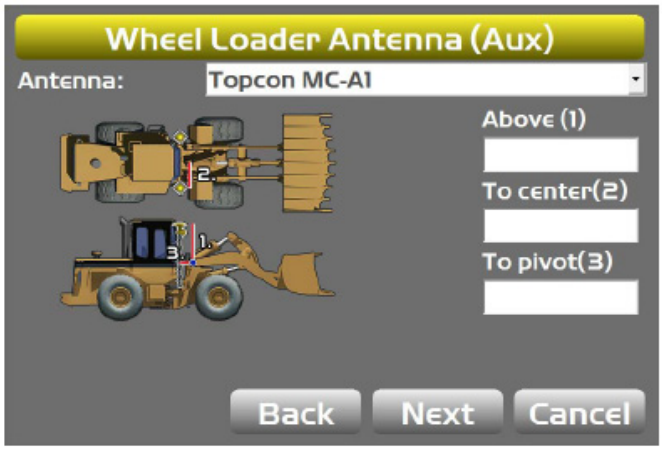


Figure 3-6: Wheel Loader Antenna (Aux)

Step 2: Designate each sensor to its corresponding implement.

NOTE For the Body, Boom, and Attachment/Bucket sensors, tap the appropriate Sensor ID box and select the serial number (last two digits) of the sensor corresponding to the machine element. Refer to your notes from installation to select the correct sensor ID from the drop-down menu.

1. Tap **Next** to navigate to the **Loader Frame/Sensor** screen (Figure 3-7).

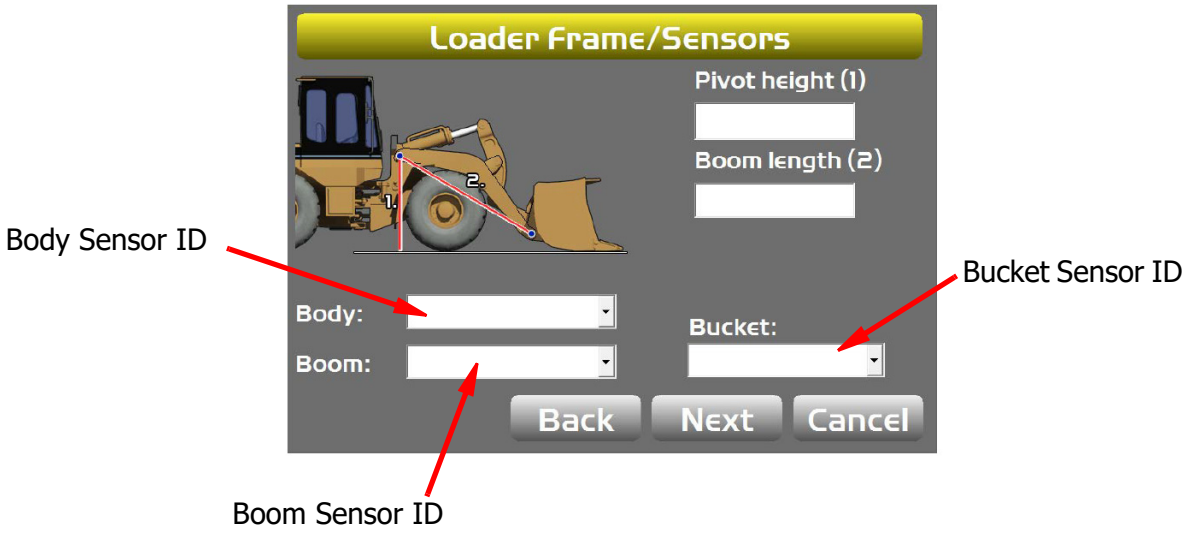


Figure 3-7: Wheel Loader Frame/Sensors

2. Tap the appropriate **Body Sensor ID, Boom Sensor ID,** or **Bucket Sensor ID** box and select the serial number (last two digits) of the sensor corresponding to the machine element that you are working on.

3. Enter the appropriate measurement values.

4. Tap **Next** on the **Loader Frame/Sensors** screen (Figure 3-7)—the **WheelLoader Bucket Setup** screen appears (Figure 3-8)

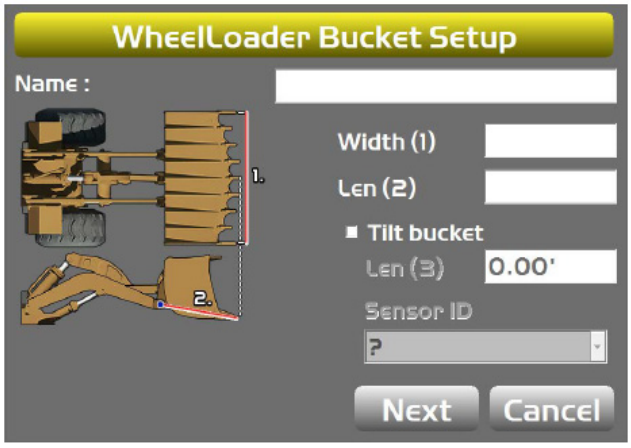


Figure 3-8: Wheel Loader Bucket Setup

a. Enter or select the appropriate data as needed (Figure 3-8).

b. Press **Next** to access the **Calibrate Attachment Angle** screen (Figure 3-9).

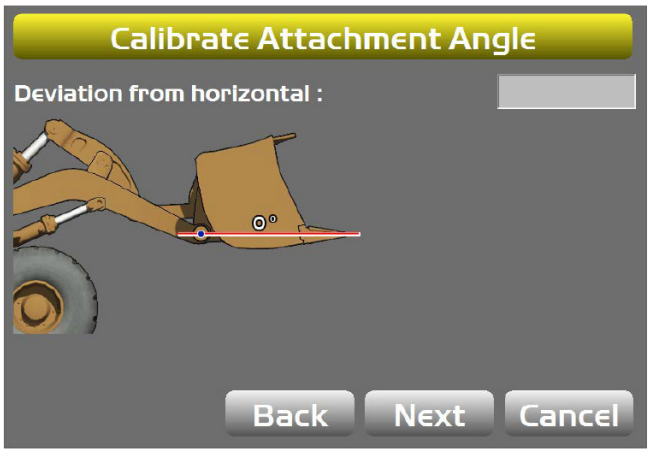


Figure 3-9: Calibrate Attachment Angle

c. Press **Next**—the **Calibrate Bucket Base** screen populates (Figure 3-10).

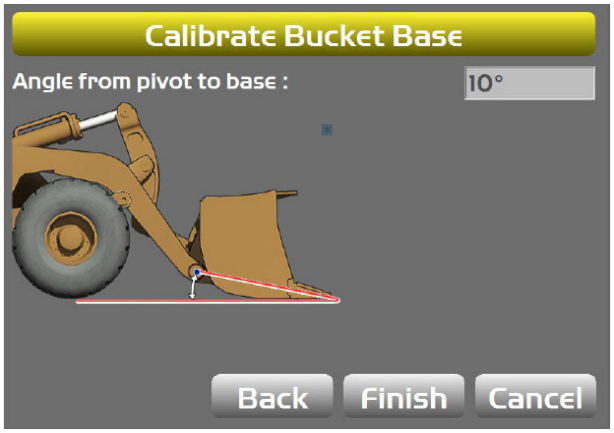
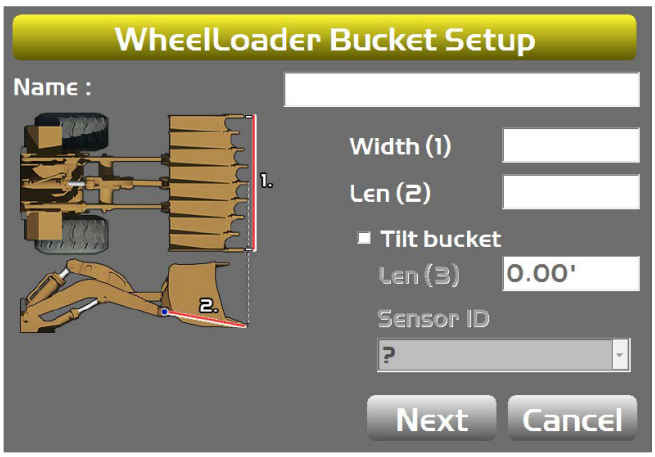


Figure 3-10: Calibrate Bucket Base

d. Press **Finish** on the **Calibrate Bucket Base** screen—to return to the **WheelLoader Bucket Setup** screen (Figure 3-11).

Bucket



Tilt Bucket

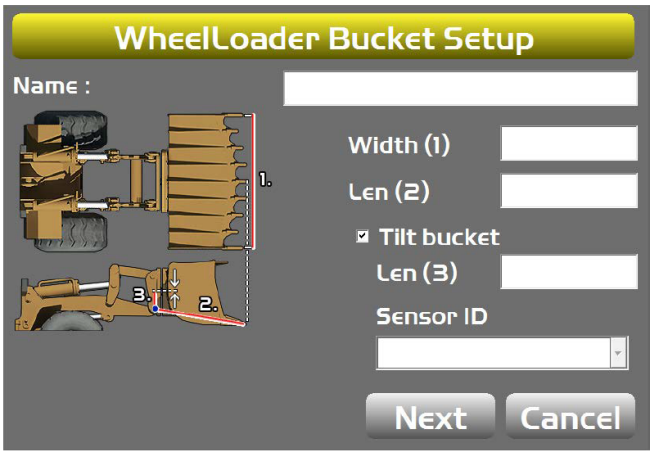


Figure 3-11: WheelLoader Bucket Setup

f. Repeat Steps 4a through 4d for each attachment.

NOTE Information regarding body, boom and attachment/bucket sensor calibration routines are described in the next chapter.

Light Bars

1. Tap **Next** to access the **Light Bars** screen.

Figure 3-12: Light Bars

2. Enter the desired settings.

Machine Configuration Complete

Tap **Next** to access the **Configuration complete!** screen.

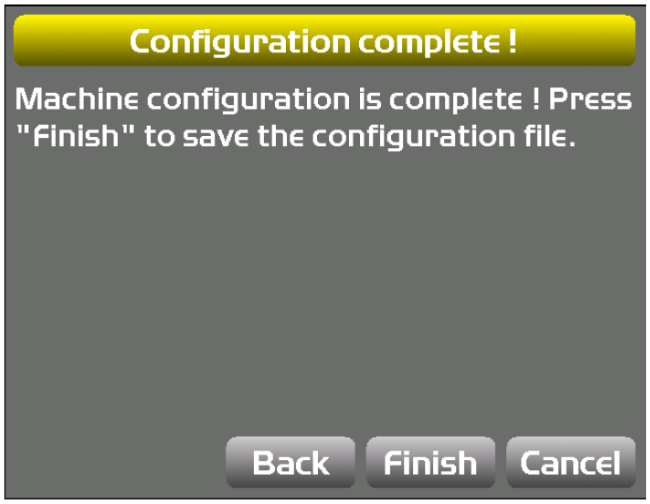


Figure 3-13: Configuration complete!

Body Sensor Calibration

Once the sensors are named, assigned to a machine element, and the sensor orientation is selected, calibrate each sensor using the 3D-MC Software Interface. Sensor calibrations can be performed at any time.

1. Using the 3D-MC Software Interface, tap **Topcon Menu Button** > **Control** > **Machine setup**.
2. Select the appropriate machine file, and tap **Edit**.
3. Continue to press **Next** to access the **Loader Frame/Sensors** screen (Figure 4-1).
4. Tap the Wrench icon for the **Body** sensor (Figure 4-1).
5. Tap the **Orientation** box, and select the physical orientation of the mounted sensor then tap **Ok** (Figure 4-1).

NOTE In Figure 4-1, Orientation is shown as **Label up,** with the **arrow forward** pointing to one of the four directions.

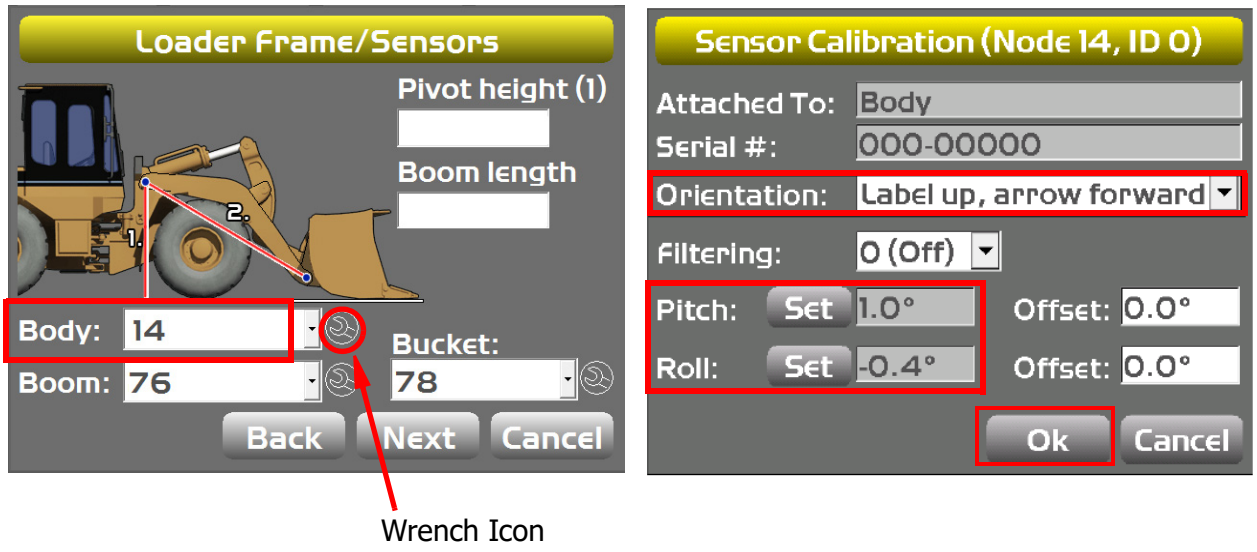
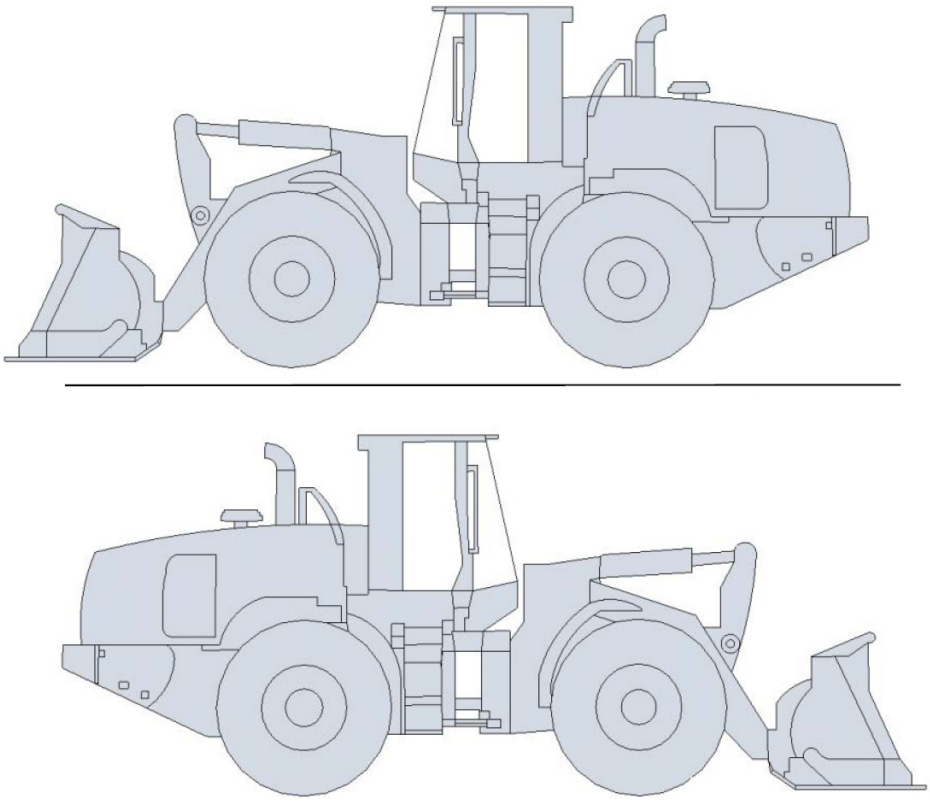


Figure 4-1: Body Sensor Calibration Screens

NOTICE **Body Sensor Calibration** requires both the **Pitch** and **Roll** calibrations. Perform both calibrations at the same time to ensure accurate measurements.

Wheel Loader Starting—Position 1



Wheel Loader Rotated 180º—Position 2

Figure 4-2: Body Calibrations for Latitudinal Slope

6. Position the machine on a flat and stable surface—free of obstructions.
7. Tap **Set** next to **Pitch**, enter the value as zero, and tap **Set** again (Figure 4-1)—repeat this step for setting the **Roll** value.
8. Mark the position on the four wheels on the ground.
9. Move the Wheel Loader around 180 degrees so that the tires are repositioned on the same ground marks.
10. Tap **Set** next to **Pitch**, set the value to half the displayed values and tap **Set** again.

NOTICE For example, (-5.3/ 2 = -2.65 and -2.8/ 2 = -1.4)—(Refer to Figure 4-1).

11. Tap **Set** next to **Roll**, set the value to half the displayed values and tap **Set** again.
12. Tap **OK**.

Boom Sensor Calibration

NOTICE When performing the **Boom Sensor Calibration**, a laser is recommended to correctly position the Boom to zero degrees.

1. Tap the **Wrench Icon** that corresponds to the **Boom** sensor (Figure 4-3).
2. Select the correct **Orientation** from the drop-down menu.
3. Ensure the Wheel Loader is parked on a flat and stable surface.
4. Place a zero slope rotating laser along the side of the Wheel Loader.

NOTICE The laser should shine on both the Boom and Bucket Pivots.

5. Adjust the laser height to strike the center of the Boom Pivot.
6. Move the **Boom** to align the Bucket Pivot with the laser.
7. Tap the **Wrench Icon** that corresponds to the **Boom** sensor.

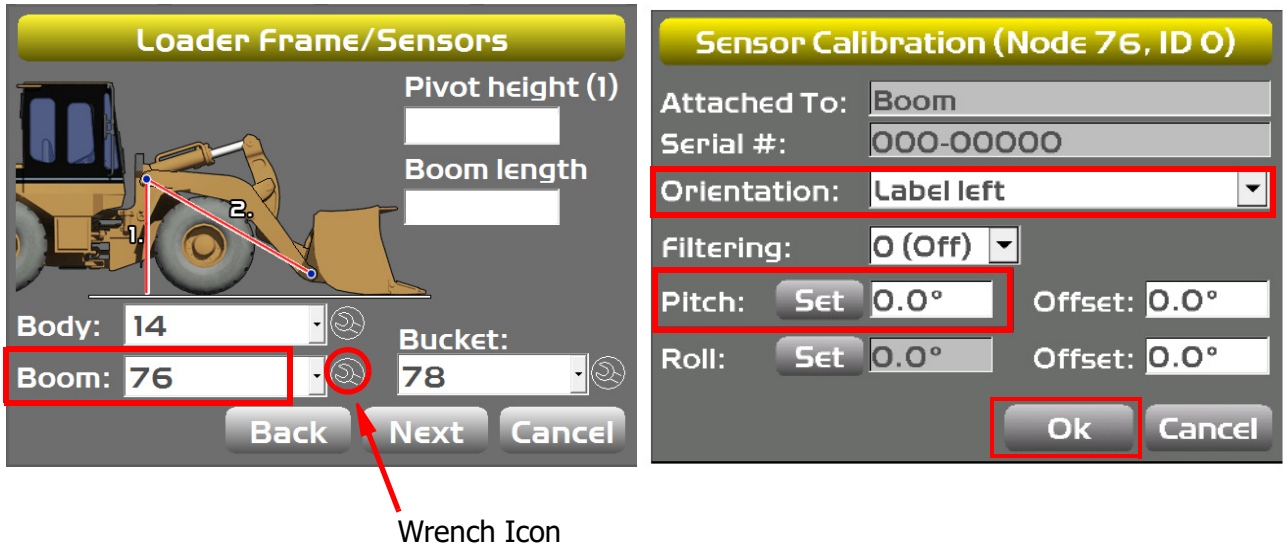


Figure 4-3: Boom Sensor Calibration Screens

8. Tap **Set** next to **Pitch** on the **Sensor Calibration** screen, enter the value as zero, and tap **Set** again (Figure 4-3).
9. Tap **Ok** to return to the **Loader Frame/Sensors** screen.

Attachment/Bucket Sensor Calibration

1. Tap the **Wrench Icon** that corresponds to the **Bucket** sensor (Figure 4-4).
2. Select the correct **Orientation** from the drop down menu.
3. Ensure that the Wheel Loader is parked on a flat and stable surface.
4. Place a zero slope rotating laser along the side of the Wheel Loader.

NOTICE The laser must shine on both the Bucket Pivot and the tip of the Bucket Cutting Edge or the Bucket Teeth.

5. Adjust the laser height to strike the center of the Bucket Pivot.
6. Rotate the **Bucket** to align to the **Bucket** Cutting Edge or the **Bucket** Teeth with the laser.

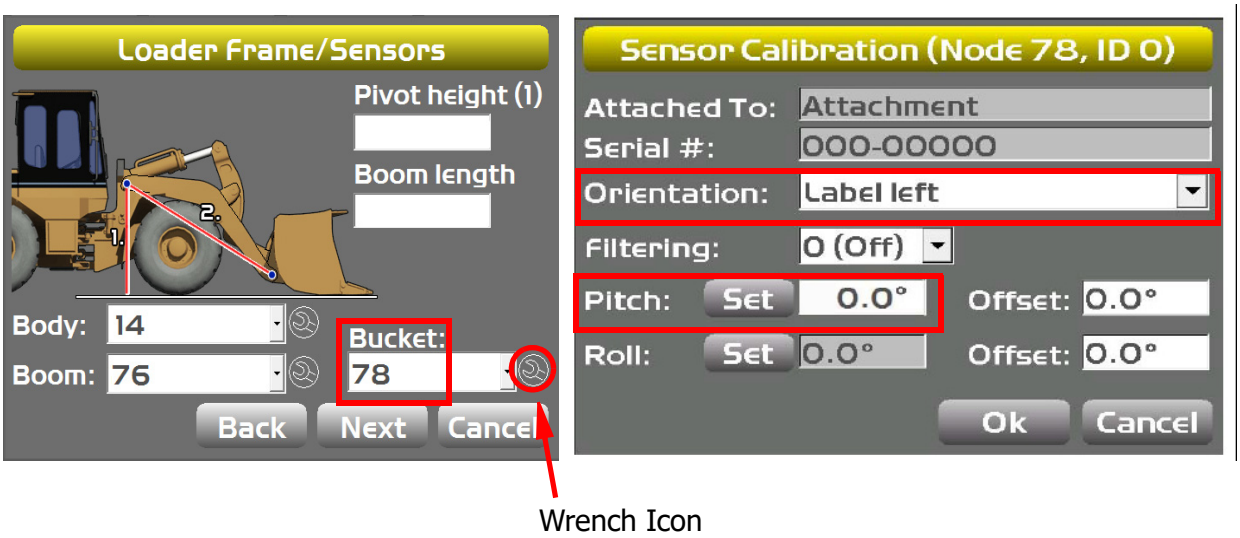


Figure 4-4: Bucket Sensor Calibration Screens

7. Tap the **Wrench Icon** that corresponds to the **Boom** sensor (Figure 4-5).

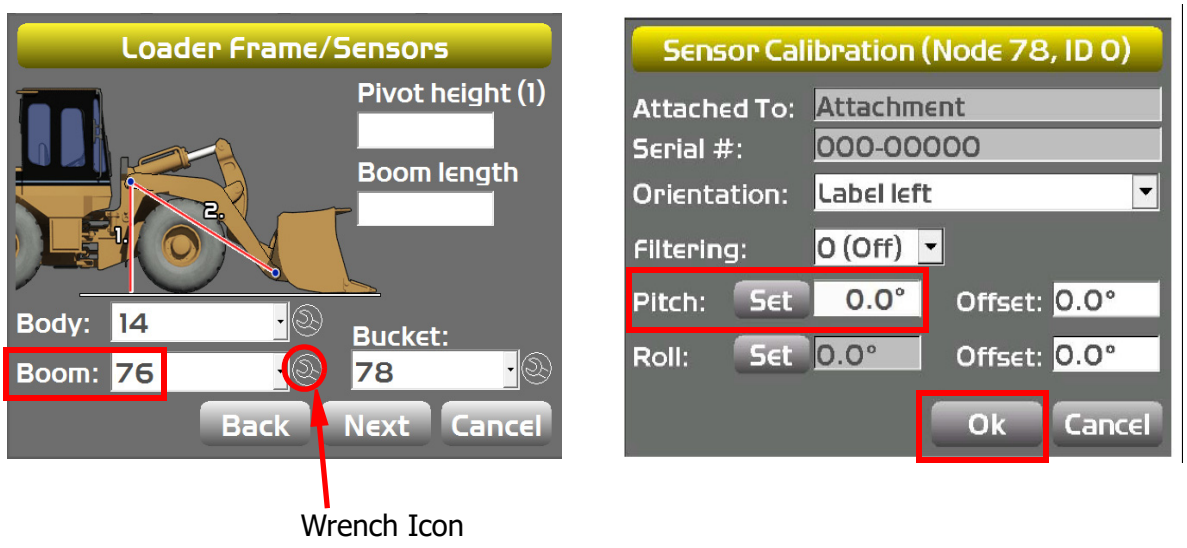


Figure 4-5: Resetting the Boom Sensor Pitch to Zero

8. Tap **Set** next to **Pitch** on the **Sensor Calibration** screen (Figure 4-5), enter the value as zero, and tap **Set** again.

9. Tap **Ok** to return to the **Loader Frame/Sensors** screen.

Attachment/Bucket Edge Sensor Calibration

Perform the following **Attachment/Bucket Edge Calibration Sensor** procedure for all attachments.

1. In 3D-MC Software Interface application, tap **Topcon Menu Button** > **Control** > **Machine setup**.

2. Tap **Next** until the **WheelLoader Buckets** screen appears (Figure 4-6).

3. Select the **Name** of the attachment that is on the **WheelLoader Buckets** screen.

4. Tap **Edit** on the **WheelLoader Buckets** screen. The **WheelLoader Bucket Setup** screen appears (Figure 4-6).

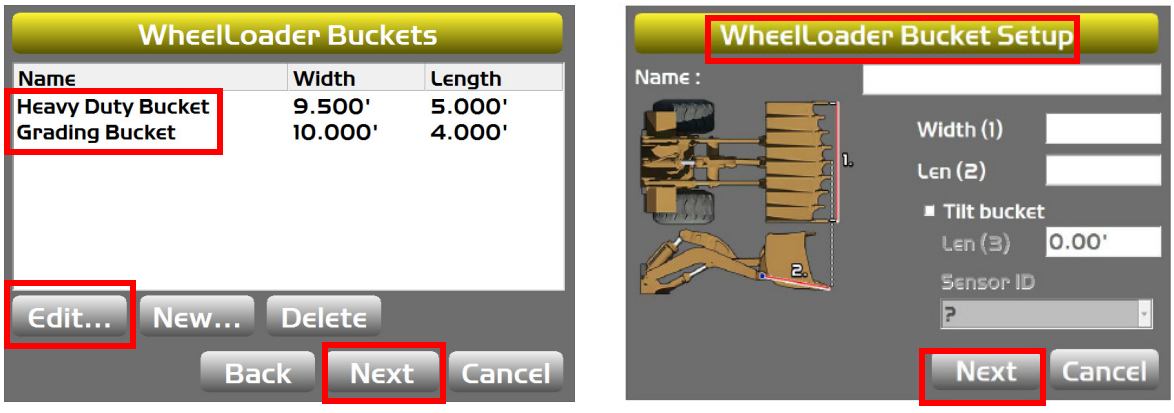


Figure 4-6: WheelLoader Buckets and WheelLoader Buckets Setup

5. Tap **Next**.

6. With the **Bucket Pivot Point** and the **Bucket Teeth** aligned at zero (0.0) degrees, tap **Next** (Figure 4-7).

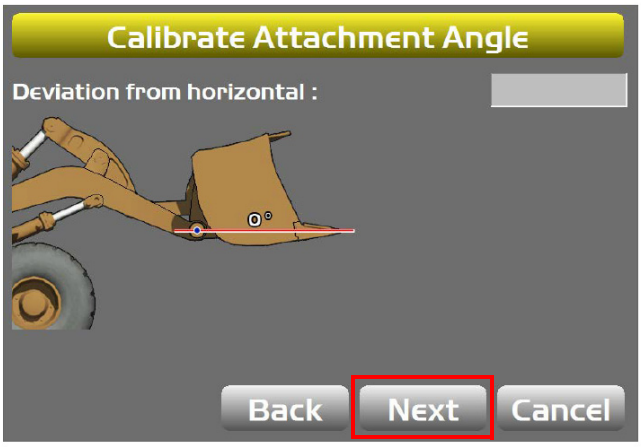


Figure 4-7: Calibrate Attachment Angle

7. Set the bottom of the **Bucket** flat on the ground and press **Finish** (Figure 4-8).

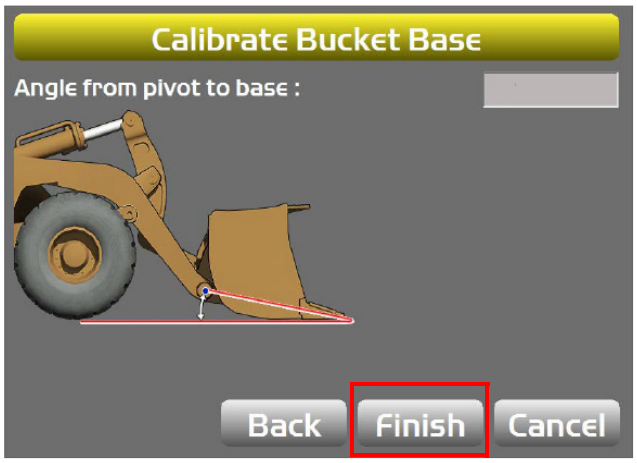


Figure 4-8: Calibrate Bucket Base

Sensor Filtering

The filter level for **each** sensor can be changed depending on the application and the operator's choice. A value of 4 (heavy filtering) will dampen sensor reaction, while a value of 1 (light filtering) will cause faster sensor reaction.

1. Using the 3D-MC Software Interface, tap **Topcon Menu Button** > **Control** > **Machine** >**Setup**. Select the applicable machine file and tap **Edit**.

2. Tap **Next** to navigate to the **Loader Frame/Sensors** screen (Figure 4-9).

3. Tap the **Wrench Icon** next to the Sensor ID that you will be adjusting.

4. Select a **Filtering** level and tap **Ok** (Figure 4-9).

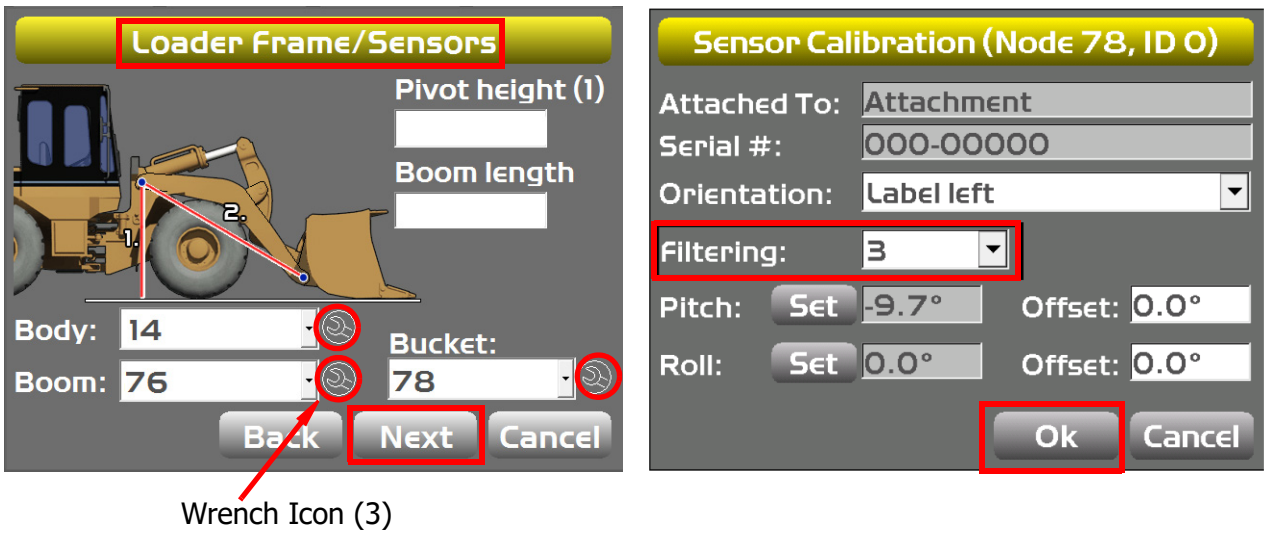


Figure 4-9: Sensor Filtering

5. Navigate through the remaining steps of Machine Setup, then save the file, and exit the 3D-MC Software Interface.

Safety Warnings

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

General Precautions

1. Read and become familiar with the machine manufacturer's operating instructions, including safety information, before installing or using your Topcon equipment.

2. Use extreme caution on the job site. Working around heavy construction equipment can be dangerous.

3. DO NOT attach system brackets or hose connections while the machine is running.

4. DO NOT allow any Wheel Loader system component to limit the visibility of the operator.

5. Use cable ties, supplied with the Wheel Loader system, to keep hoses and wires secured and away from possible wear or pinch points.

6. Use eye protection whenever welding, cutting, or grinding is being done on the machine.

7. 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 turned off.

CAUTION Relieve all pressure in the hydraulic lines before disconnecting or removing any lines, fittings or related components. In case of injury, seek medical assistance immediately.

8. Avoid direct exposure to your eyes when using laser control.

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

9. Use appropriate welding precautions and practices when welding. After welding, all paint all affected areas with a rust inhibitor

WARNING DO NOT weld near hydraulic lines or on any equipment when in operation.

WARNING Disconnect all Topcon system electrical cables prior to welding on the machine.

CAUTION All mounting bracket welds must be secure and strong to prevent sensor equipment from vibrating excessively or from becoming detached at the weld during operation.

10. To prevent vandalism or theft, do not leave removable Topcon components on the machine at night. Remove the components each evening and store appropriately in the carrying case.

11. Keep the carrying case dry at all times.

NOTICE DO NOT allow moisture to get inside the case. Moisture trapped in the case can adversely affect the components. If moisture does enter the carrying case, leave it open and allow it to thoroughly dry before storing any components.

Radio Usage Information

All users must obtain an FCC (Federal Communications Commission) license before operating the GPS+ system, GPS RTK (Real-Time Kinematic), or simultaneous calculation of Global Positioning System and Global Navigation Satellite System.

- The Federal Communications Commission is at: http://www.fcc.gov/
- The rules are at: http://www.access.gpo.gov/nara/cfr/waisidx_00/47cfr90_00.html

There have been many problems in the past with RTK base radio modems interfering with voice users. The issue finally culminated with the FCC refusing to grant licenses until something was done to ensure that surveyors did not interfere with voice users. The solution was to stop using frequencies in the 469 MHz range, to add an identifier to the broadcast message, and other measures designed to minimize interference with voice users. The user and his employer are subject to fines of up to $82,500, confiscation of surveying equipment and legal action, if the rules are ignored.

Topcon cannot obtain the license for the user. There are companies to assist with licensing. Two are listed here:

Professional Licensing Consultants Inc.

P.O. Box 1714

Rockville, MD 20849-1714

Atlas License Company and Data Services

1725-A North Shadeland Avenue

Indianapolis, IN 46219

http://www.alcds.com/

Usage Warnings

CAUTION	If this product has been dropped, altered, transported or shipped without proper packaging, or otherwise treated without care, erroneous measurements may occur. The owner should periodically test this product to ensure it provides accurate measurements. Inform TPS immediately if this product does not function properly.

www.topconpositioning.com