TOPCON

X-63/X-63i/X-62/X-33/X-32

Excavator Indicate Systems

Installation and Calibration Manual

SYNERGY
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X-63/X-63i/X-62/X-33/X-32 Installation and Calibration Manual

Part Number 7010-0697
Rev. E

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Preface

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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**)
Bold	Name of a dialog box or screen	From the **Connection** screen...
Bold	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 Quick Guide.*

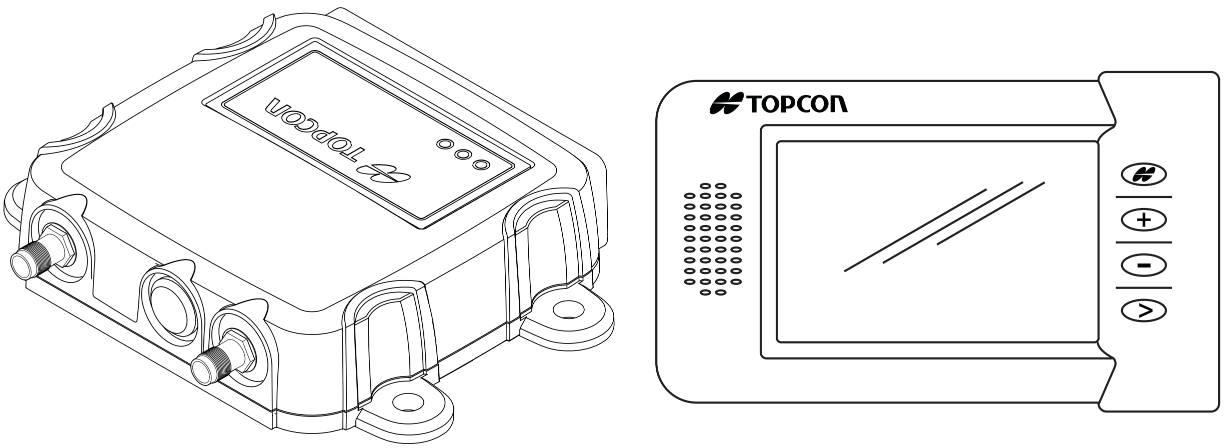
Further information to note about system configuration, maintenance, or setup.

Supplementary information that can have an adverse effect on system operation, system performance, data integrity, measurements, or personal safety.

Notification that an action has the potential to result in system damage, loss of data, loss of warranty, or personal injury.

What's New with the Excavator Systems

The X-63i system uses the GX-60 Control Box (9169-0000) and MC-i3 GNSS Receiver (Figure 1). The X-33 and X-32 systems use the MC-i3 GNSS Receiver and GX-30 Control Box. The X-62 and X-32 systems now support an optional compass.



MC-i3 GNSS Receiver GX-30 Control Box

Figure 1: The MC-i3 GNSS Receiver and GX-30 Control Box

Introduction

This manual discusses how to install and calibrate the X-63/X-63i/X-33 GPS excavator indicate systems for 3D control, and the X-62/X-32 excavator indicate systems for 2D control.

The TS-i3 and TS-1 Tilt Sensors (9174-0001) used in the Topcon excavator systems measure the pitch and roll angle of various machine elements (Figure 2). Each sensor accurately measures a gravity-referenced angle of the body, boom, stick and bucket, sending this angle data to a GX-60 or GX-30 Control Box to provide precise grade. Each sensor is configured and calibrated for its specific location on the excavator.

The body sensor functionality is unique as it measures both pitch and roll (cross slope) of the machine.

3D Excavator Indicate Systems

Table 1 lists the components of the different 3D indicate systems.

Table 1. 3D Indicate System Components

X-63i	X-63	X-33
TS-1 Tilt Sensors	TS-1 Tilt Sensors	TS-i3 Tilt Sensors
GX-60 Control Box	GX-60 Control Box	GX-30 Control Box
MC-i3 GNSS Receiver	MC-R3 GNSS Receiver	MC-i3 GNSS Receiver
GPS Antennas (2)	GPS Antennas (2)	GPS Antennas (2)

Figure 2 shows the position of the sensors for 3D indicate systems.

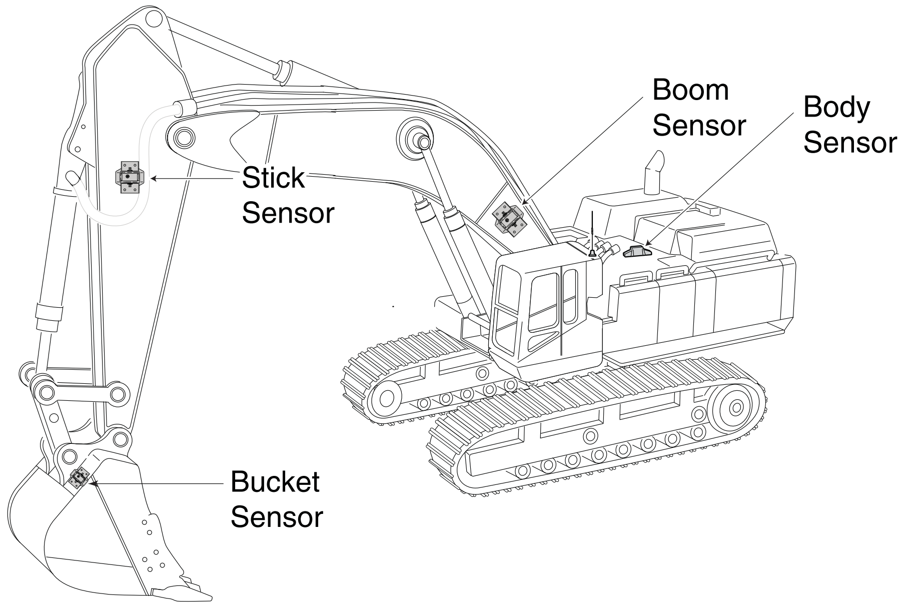


Figure 2: Tilt Sensors on an Excavator

Sitting in the cab facing forward, the sensor angles are 0° straight ahead (horizontal), +90° straight up, and -90° directly down (Figure 3).

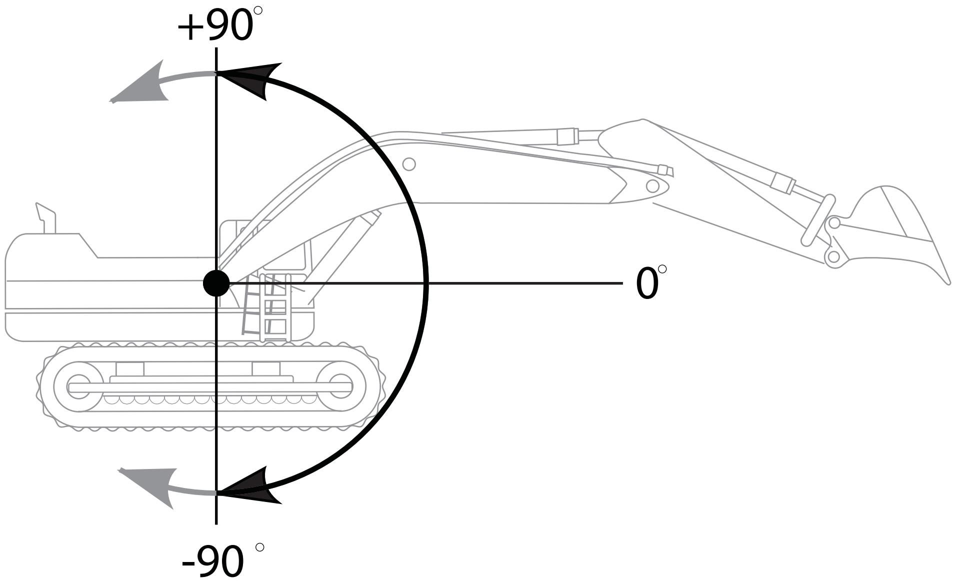


Figure 3: Angle Convention Used For Tilt Sensors

The Main and Auxiliary antennas provide positional and heading information.

- Main antenna – determines 3D machine position.
- Aux antenna – determines heading using relative position.

Using the TS-1 or TS-i3 sensors, the 3D position of the bucket is projected from the Main antenna.

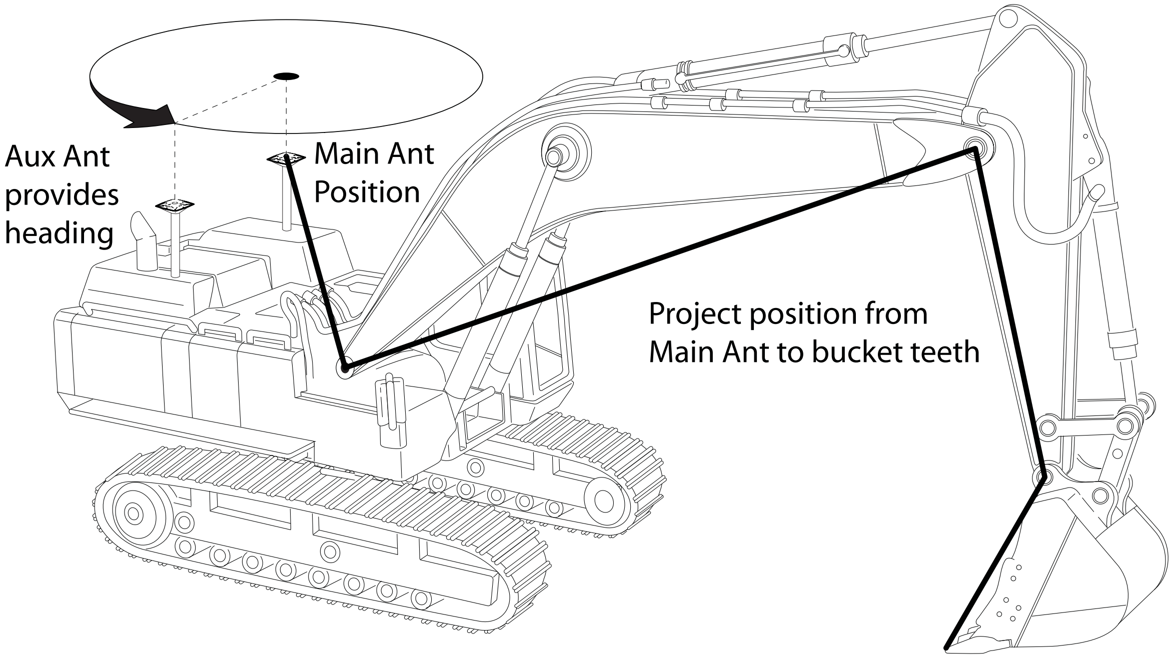


Figure 4: Tilt Sensor Positional and Heading References

X-63i

Figure 5 shows the basic cabling connections for the X-63i system. When installing components, use the Topcon supplied fuse or fused power from the machine of the same rating.

System ground must be connected to the frame side of the ground disconnect switch, not directly to the negative battery terminal.

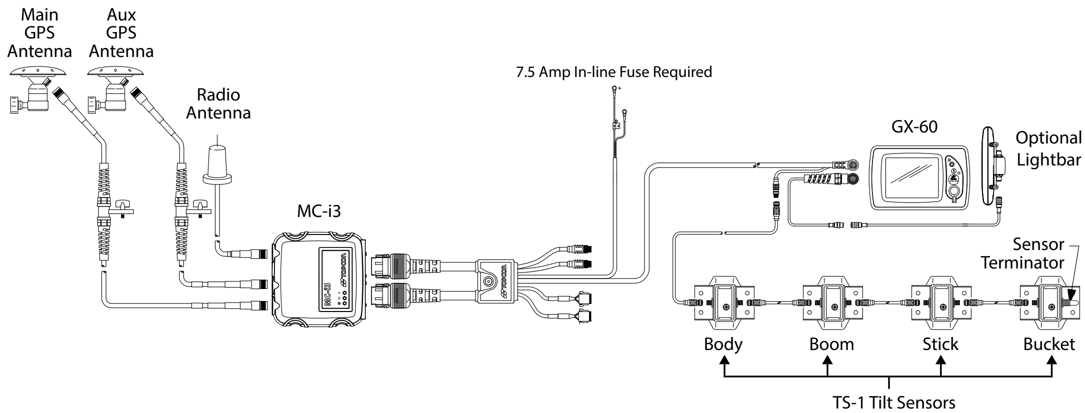


Figure 5: Basic Cable Connections for the X-63i System

X-63

Figure 6 shows the basic cabling connections for the X-63 system. When installing components, use the Topcon supplied fuse or fused power from the machine of the same rating.

System ground must be connected to the frame side of the ground disconnect switch, not directly to the negative battery terminal.

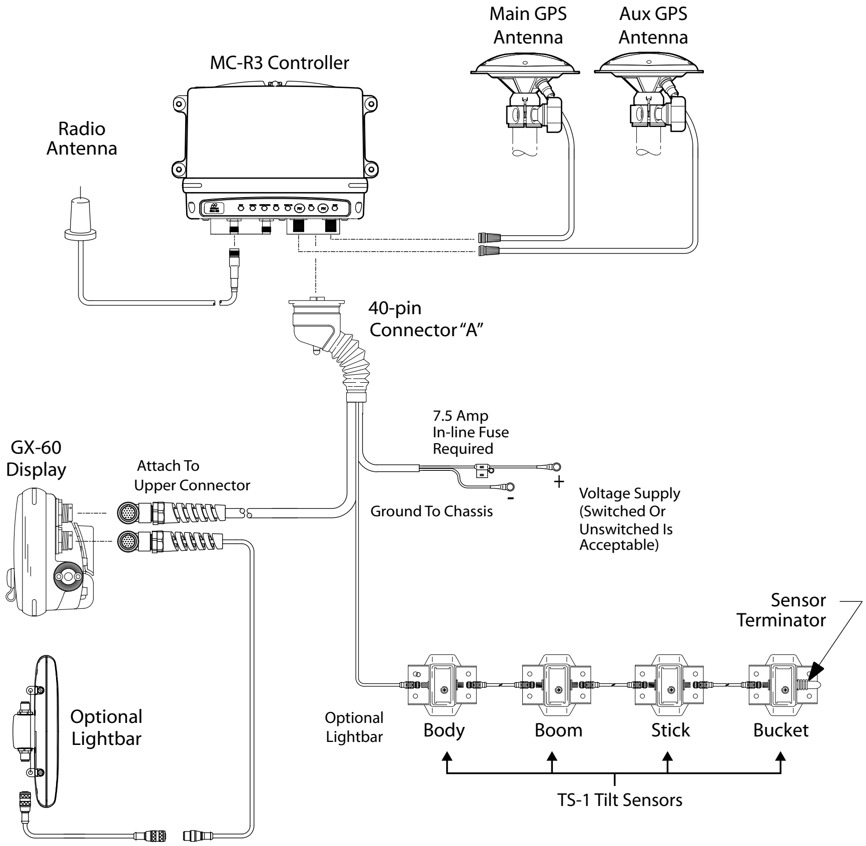


Figure 6: Basic Cable Connections for the X-63 System

X-33

Figure 7 shows the basic cable connections for the X-33 system. When installing components, use the Topcon supplied fuse or fused power from the machine of the same rating.

System ground must be connected to the frame side of the ground disconnect switch, not directly to the negative battery terminal.

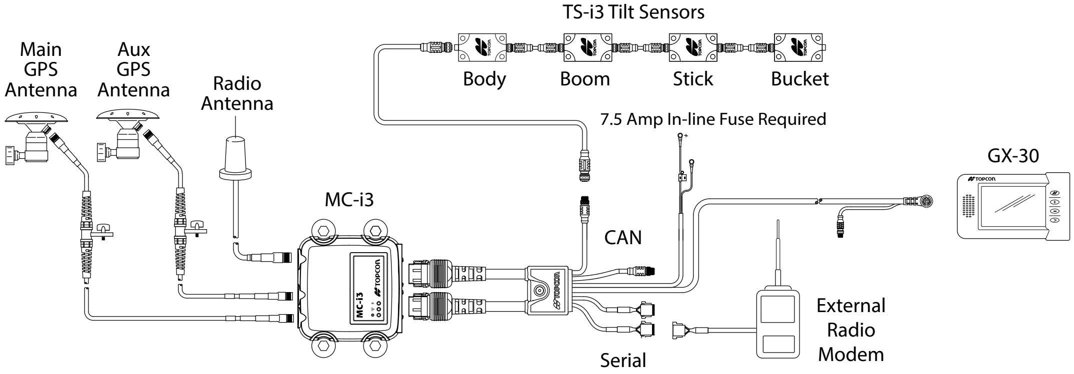


Figure 7: Basic Cable Connections for the X-33 System

2D Excavator Indicate Systems

Table 2 lists the components of the different 2D indicate systems

Table 2. 2D Indicate System Components

X-62	X-32
TS-1 Tilt Sensors	TS-i3 Tilt Sensors
GX-60 Control Box	GX-30 Control Box
LS-B10W Laser Receiver	MC-i3 GNSS Receiver
Compass	Compass

X-62

The TS-1 Tilt Sensors, the GX-60 Control Box, and the LS-B10W Laser Receiver make up the X-62 indicate system. The LS-B10W adds a laser height reference, and is calibrated for its location on the stick of the excavator.

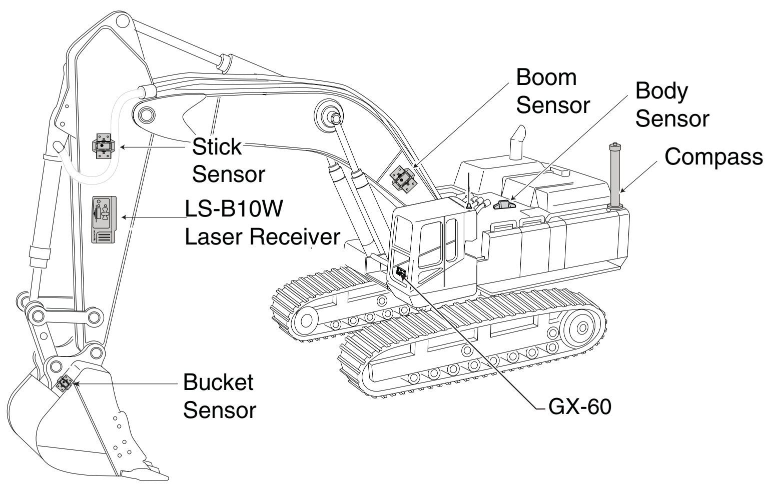


Figure 8: Machine Components of the X-62 System

Figure 9 shows the basic cabling connections for the X-62 system. When installing components, use the Topcon supplied fuse or fused power from the machine of the same rating.

System ground must be connected to the frame side of the ground disconnect switch, not directly to the negative battery terminal.

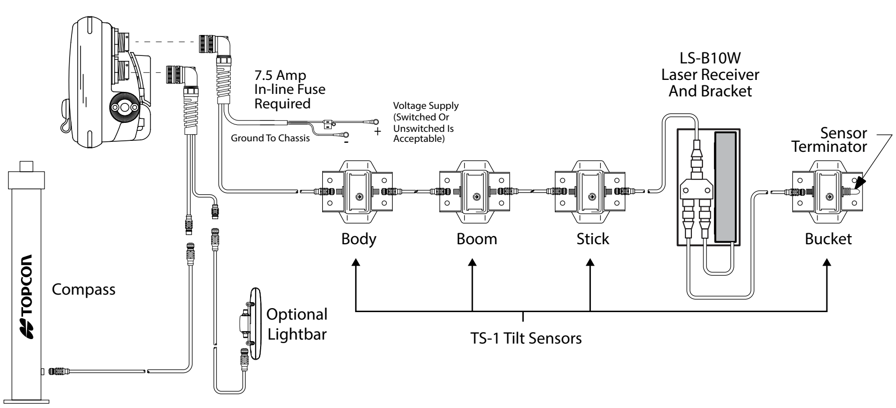


Figure 9: Basic Cable Connections for the X-62 System

X-32

The X-32 system contains TS-i3 Tilt Sensors, the GX-30 Control Box, and the MC-i3 GNSS Receiver.

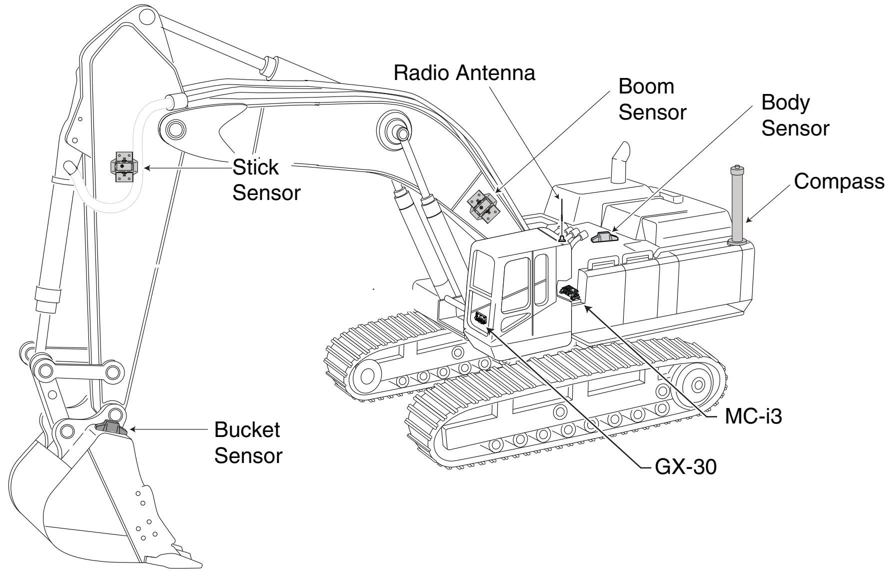


Figure 10: Machine Components of the X-32 System

Figure 11 shows the basic cabling connections for the X-32 system. When installing components, use the Topcon supplied fuse or fused power from the machine of the same rating.

System ground must be connected to the frame side of the ground disconnect switch, not directly to the negative battery terminal.

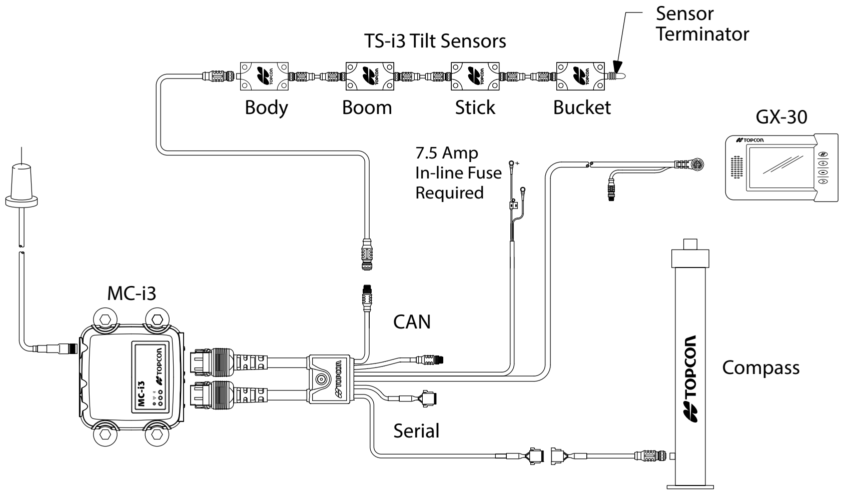


Figure 11: Basic Cable Connections of the X-32 System

Sensor Installation

When mounting the tilt sensors, begin with the bucket to help simplify cable routing.

TS-1 Sensor Installation

Each TS-1 sensor contains a 3-axis 360° sensor element which must be configured depending on the mounting position. The TS-1 Tilt Sensors can be mounted in many orientations as long as they are parallel to the axis being measured (Figure 12). 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 sensor name plate. This direction is needed during calibration. The calibration process uses 3D-MC to enter direction, orientation, and other sensor variables.

TS-1 Sensor Orientation

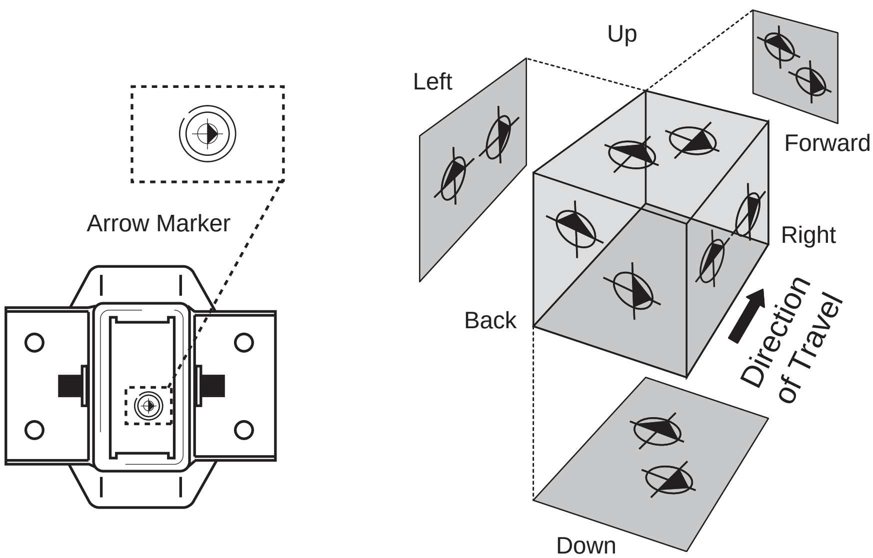


Figure 12: TS-1 Arrow Marker Location and Direction

Table 3 indicates arrow marker direction options once the mounting surface has been selected. These directions assume the mounting surface is at zero degrees.

Table 3. Marker Direction Options

Mounting Surface	Marker Direction Options	
Back	Right	Up
Down	Forward	Right
Forward	Right	Up
Left	Up	Forward
Right	Forward	Up
Up	Forward	Right

TS-i3 Sensor Installation

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

When installing the sensors, ensure that they are mounted parallel to the axis being measured with the direction arrow pointing away from the cab (Figure 13). 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

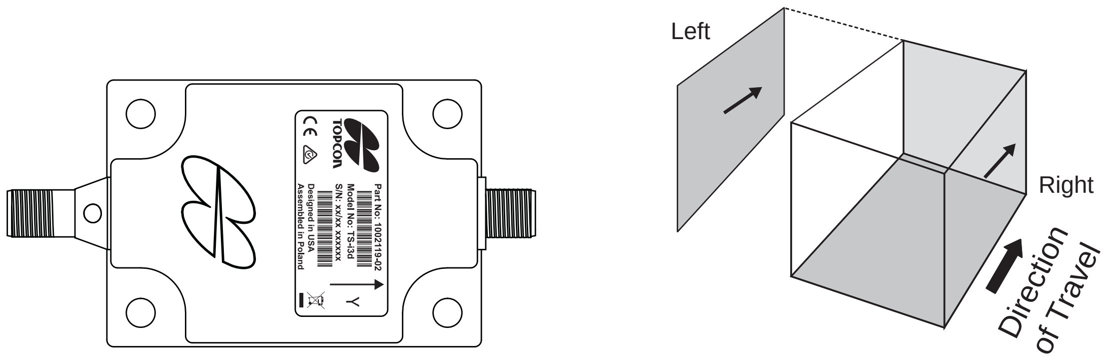


Figure 13: TS-i3 Sensor Location and Direction

Mounting each tilt sensor within +/- 20° of the pivot centerline is a good practice. Though not necessary for system performance, squaring the sensors to each part of the machine makes for a cleaner looking installation.

All tilt sensor orientation is determined when the implement is horizontal (zero degrees). The orientation of each tilt sensor is entered in 3D-MC.

Bucket Sensor Mounting

The bucket sensor is the most challenging sensor to mount to keep the sensor and cables protected.

Fabrication of a sensor guard and cable protection is required to minimize damage.

Because this varies widely, such specific protection is not included in the Topcon kit and must be supplied by the installer.

The easiest and most accurate location to mount the sensor is on the top left side of the bucket — from the cab perspective— with the arrow pointing forward (toward the direction of travel). The safest, but less accurate, location to mount the sensor is on the left side of the dog-bone; see “Dog-bone Sensor Mounting (Optional)” on page 12.

TS-i3 sensors are only mounted on the left or right of the bucket.

When mounting the bucket sensor, keep the following in mind (Figure 14):

- Position the bucket at zero degrees before mounting the sensor.
- Sensor orientation (Up/Forward, etc.) references the position of the bucket at zero degrees.

When using a quick-release bucket, mount the sensor to the quick-release, not the bucket.

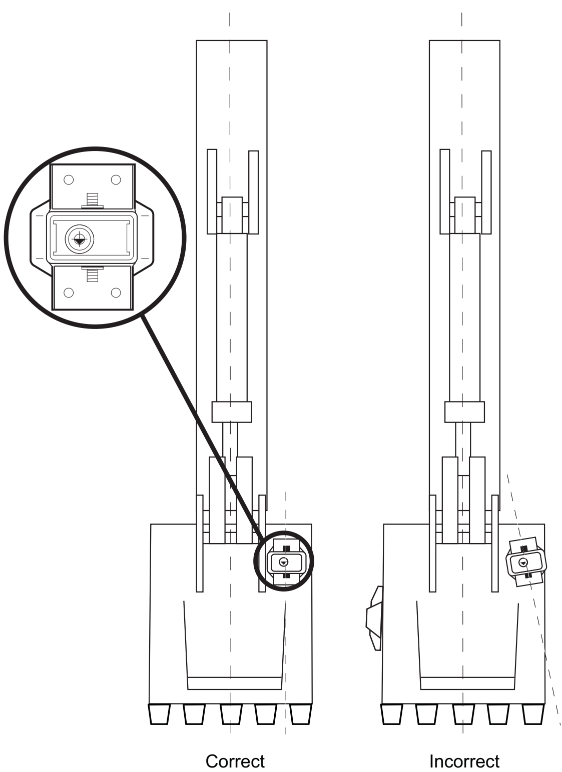


Figure 14: Bucket Sensor Mounting

Dog-bone Sensor Mounting (Optional)

An optional location for the bucket sensor is on the dog-bone. This location offers additional protection of the sensor, but produces less accurate readings (especially if the joints are worn). If possible, placing the sensor on the inside of the dog-bone will provide additional protection. Mounting the sensor on the dog-bone requires additional calibration steps.

If using the dog-bone mounting option, worn joints in the dog-bone linkage will cause decreased accuracy.

TS-i3 sensors are only mounted on the left or right of the dog-bone.

The orientation of the dog-bone mounted bucket sensor marker is determined when the dog-bone is horizontal (zero degrees) as shown in Figure 15. Orientation is selected in the **Sensor Calibration** screen in 3D-MC.

The recommended location of the sensor is on the left side of the dog-bone with the arrow pointing forward, toward the direction of travel.

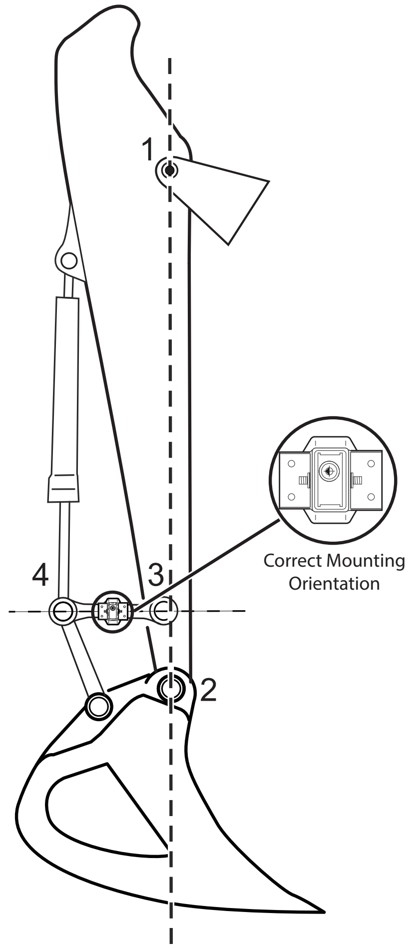


Figure 15: Dog-bone Sensor Mounting Example

Tilt Bucket Sensor Mounting (Optional)

If using tilt bucket, an additional sensor may be mounted to the bucket (Figure 16). Tilt bucket sensor mounting differs from all other sensors. Determine the location and orientation of the sensor with the bucket hanging vertically.

The recommended location of the sensor is on the top side of the bucket —from the cab perspective— with the arrow pointing forward (toward the direction of travel). If using a TS-i3 sensor, mount it either on the top left or top right with the arrow pointing toward the direction of travel.

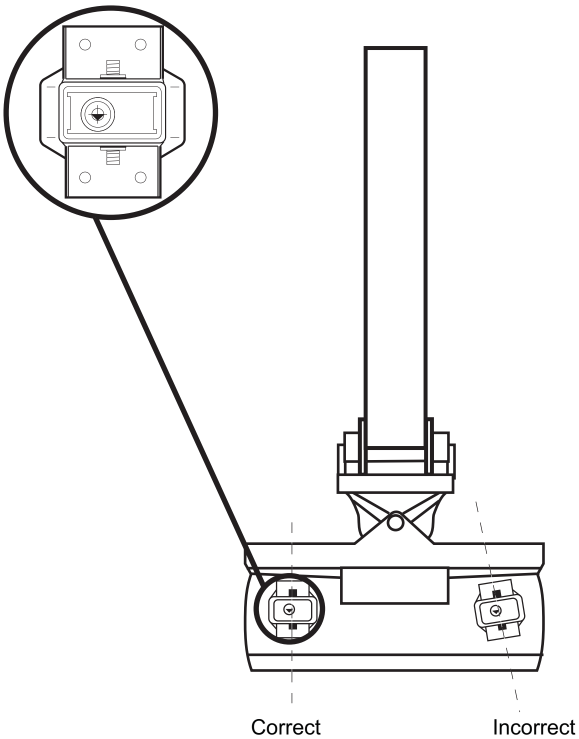


Figure 16: Tilt Bucket Sensor Mounting

Stick Sensor Mounting

Locate a convenient surface to mount the sensor. Mounting the sensor close to the top of the stick will help prevent damage during digging.

The recommended mounting location is on the left side of the stick (from the cab point of view) with the arrow pointing forward toward the direction of travel, when the stick is extended (Figure 17 on page 14).

If mounting the sensor on the front of the stick, make sure the sensor is parallel to the stick-to-bucket centerline (Figure 17).

TS-i3 sensors are only mounted on the left or right of the stick.

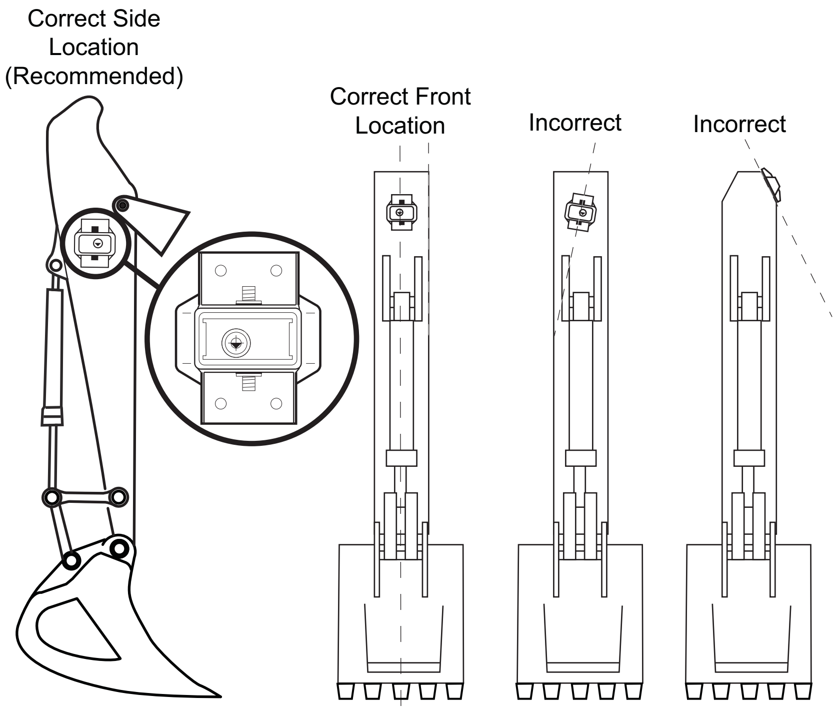


Figure 17: TS-1 Stick Sensor Mounting

Boom Sensor Mounting

For the boom sensor, locate a convenient surface parallel to the boom center. The recommended mounting location is up, on the top of the boom, with the arrow pointing forward toward the direction of travel (Figure 18).

If mounting on the side of the boom, because many booms will taper out at the boom pivot, be sure to place the sensor at a location away from the boom pivot

Placing the boom sensor on a tapered section will cause calculation errors.

TS-i3 sensors are only mounted on the left or right of the boom.

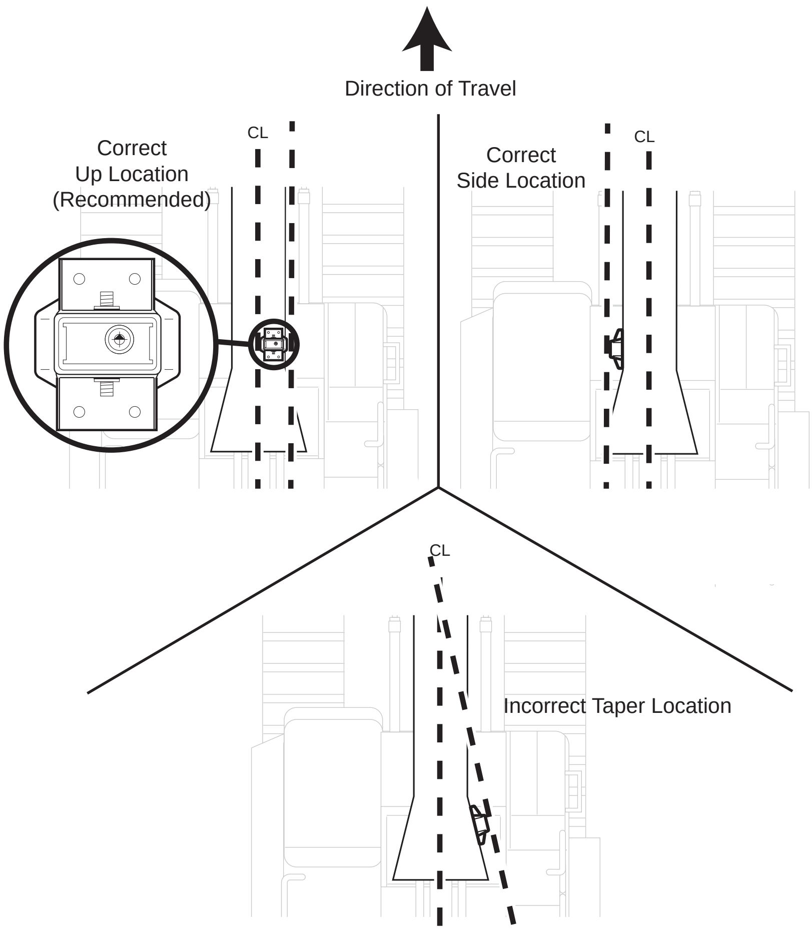


Figure 18: Boom Sensor Mounting

Secondary Boom Sensor Mounting (Optional)

See the previous section “Boom Sensor Mounting” on page 15 for secondary boom sensor mounting locations.

Body Sensor Mounting

For the body sensor, locate a convenient surface parallel to the boom pivot. The sensor must be lined up with the center line of the boom. The recommended mounting location is up, on top of the body, with the arrow pointing forward toward the direction of travel (Figure 19).

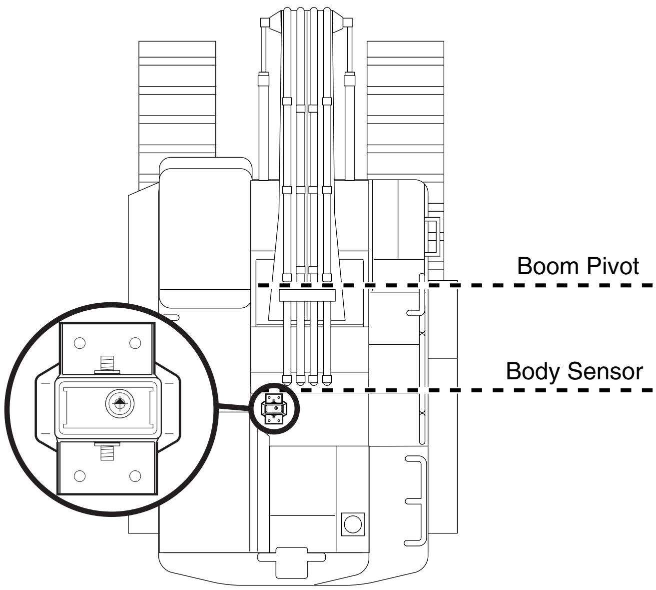


Figure 19: Body Sensor Mounting - Top View

If using a TS-i3 sensor, mount it either on the left, right, or top of the body with the arrow pointing toward the direction of travel.

Machine Calibration

Before calibrating the sensors, note the following:

If using the dog-bone mounting option, worn joints in the dog-bone linkage will cause decreased accuracy.

Check the 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 address ("02"), causing communication errors.
A sensor ending in 00 is considered a special CAN identifier, and will be identified as 01 in 3D-MC; therefore; if you have a sensor with 00 and a sensor with 01, there will be some confusion in 3D-MC.

The best practice is to perform the machine calibrations as ordered in this manual. Performing the calibrations out of order will not affect system performance. The exception to this is when using a dog-bone sensor. You must calibrate the stick sensor before calibrating the dog-bone sensor.

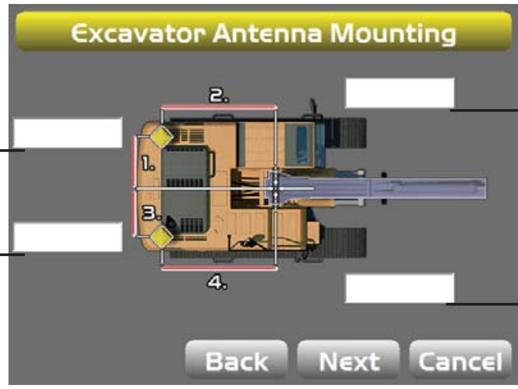
Machine Measurements

Accurately measure and enter the machine dimensions into the 3D-MC machine builder, and write your measurements on the lines at the side of the following screen captures. Verification and adjustments for several critical lengths are described in "Verifying Setup" on page 47.

Incorrect measurements or data entry errors have a direct affect on excavating accuracy.
Take each measurement twice to ensure accuracy.

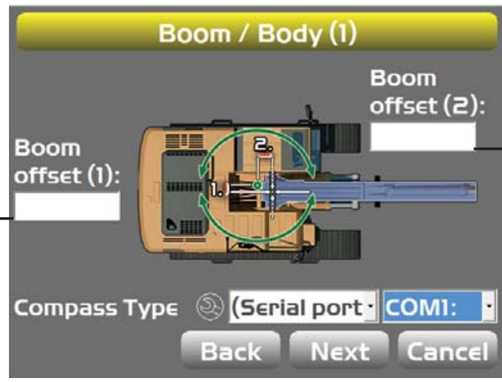
.

Antenna Positions

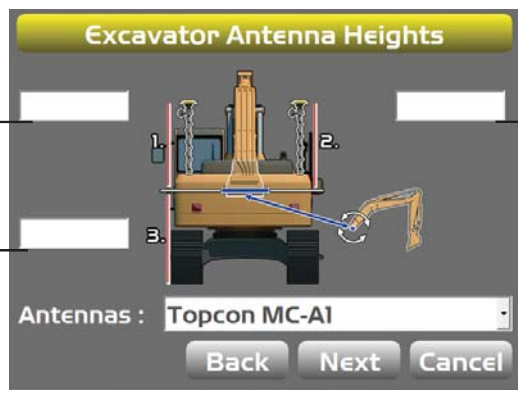


Center of Rotation

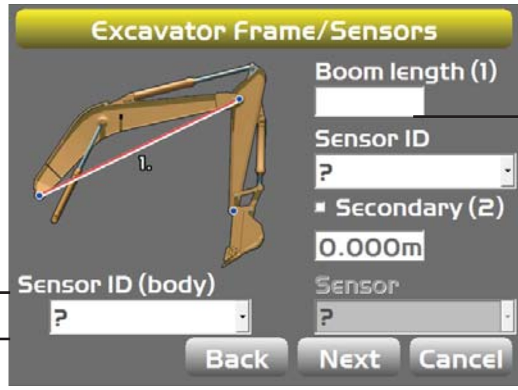
Note: For 2D mode only



Antenna Heights



Boom Length



Sensor ID

Orientation

Sensor ID

Orientation

Stick Length

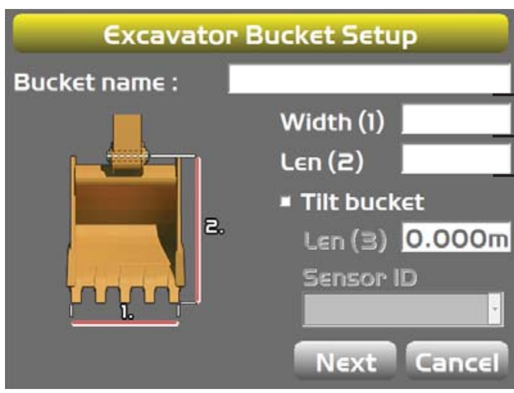
Sensor ID

Orientation

Bucket Width and Length
(repeated for each bucket)

Note: Multiple buckets may be set up at any time. When ready for use, ensure that the desired bucket is calibrated (see pg. 30).

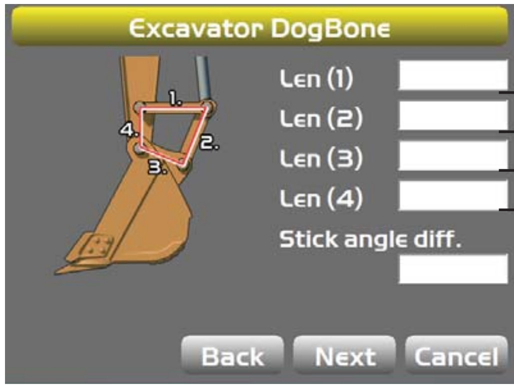
Record Sensor ID and orientation for all sensors.



Sensor ID

Orientation

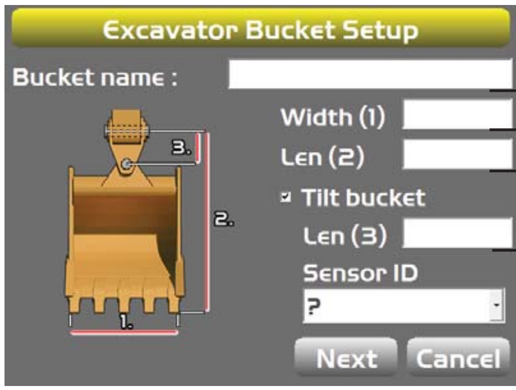
DogBone Lengths



Note: Stick angle difference is determined during calibration of the machine.

Tilt Bucket Length

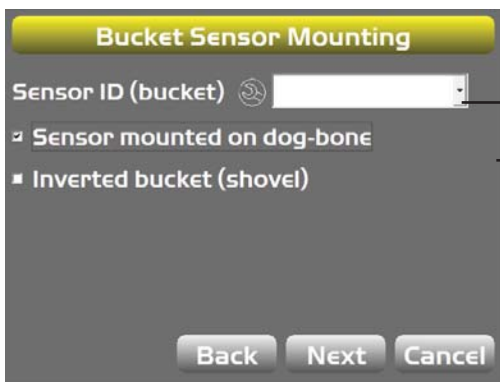
Note: When checked, the measurement for the Tilt Bucket will be available.



Sensor ID

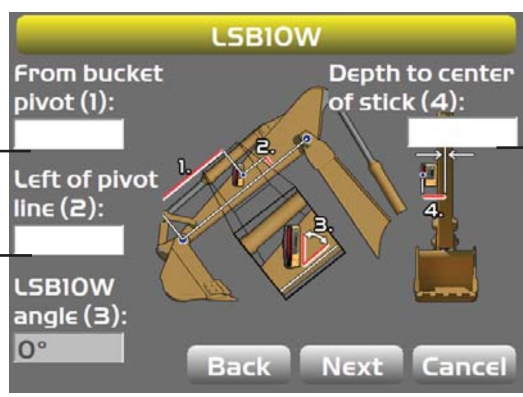
Orientation

Sensor ID and Orientation



Sensor ID

Orientation



2D Mode:
LS-B10W Laser Receiver Depth, Angle to the Stick Center Line, Distance from Bucket to Pivot, and Distance from Left of Pivot line.

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 3D-MC. You will need the following information:

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

When entering sensor information, make note of each sensor's serial number and its orientation. TS-i3 sensor orientation is only left or right.

Step 1: Select the location for each sensor to easily identify it during the calibration and setup processes.

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.
   Refer to the *3D-MC Reference Guide P/N 7010-0911* for the for further information on creating a machine file.
3. On the **Configuration name/type** screen, enter or select the appropriate data as needed (Figure 20).

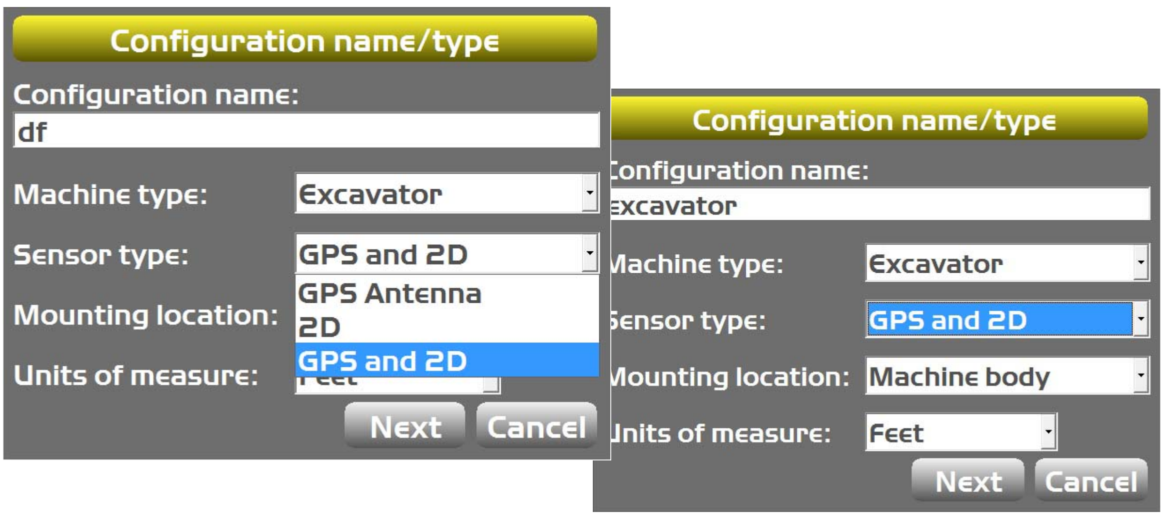


Figure 20: Configuration name/type Screen

4. Tap **Next** to navigate to the **Excavator Options** screen and select **MC-R3**, **MC-i3 (SITELINK)**, or **MC-i3 (UHF/SS)** as the **Position Input** (Figure 21 on page 22).

5. Select **GX-60** or **GX-30** for **Sensor Input** (depending on your system configuration).

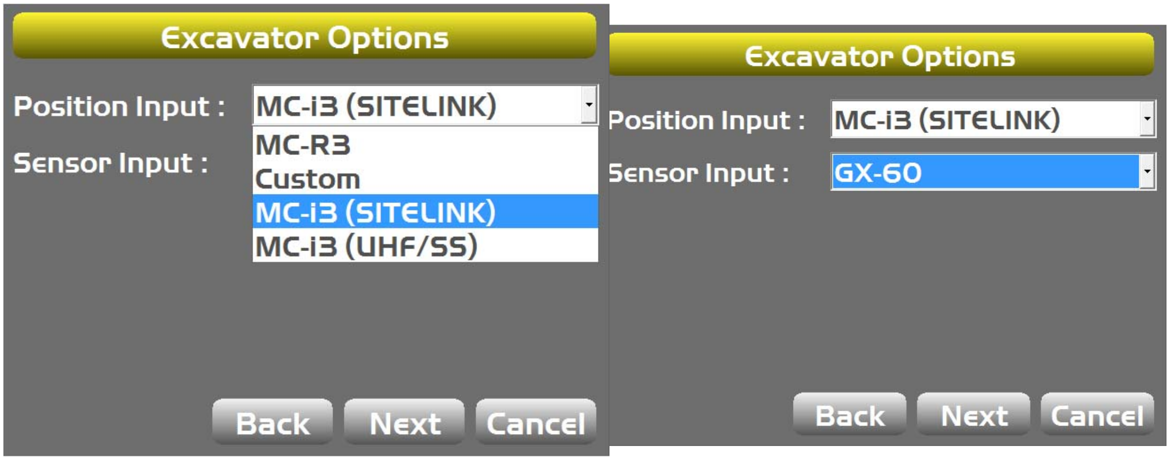


Figure 21: Select the Appropriate Position and Sensor Input

6. Tap **Next** to navigate to the **Excavator Antenna Mounting** screen, and select the appropriate values as needed.
7. Tap **Next** to navigate to the **Excavator Antenna Heights** screen, and select the appropriate values as needed.
8. Tap **Next** to navigate to the **Excavator Frame/Sensor** screen (Figure 22).

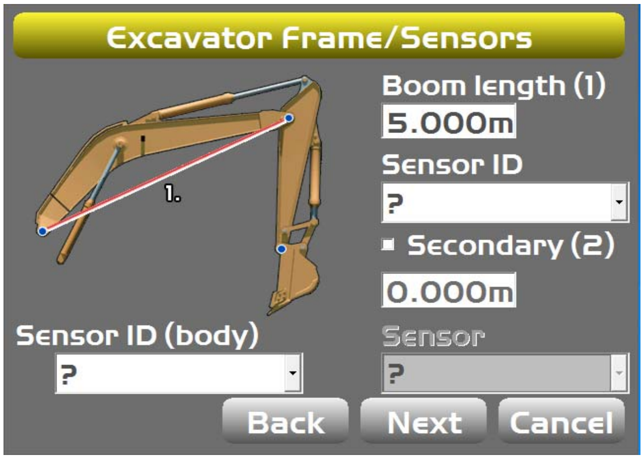


Figure 22: Select Body and Boom Sensor ID

9. Tap the appropriate **Sensor ID** box and select the serial number (last two digits) of the sensor corresponding to the machine element.
10. Repeat step 8 for the remaining sensors.

11. Tap **Next** to access the **Excavator Stick** screen.

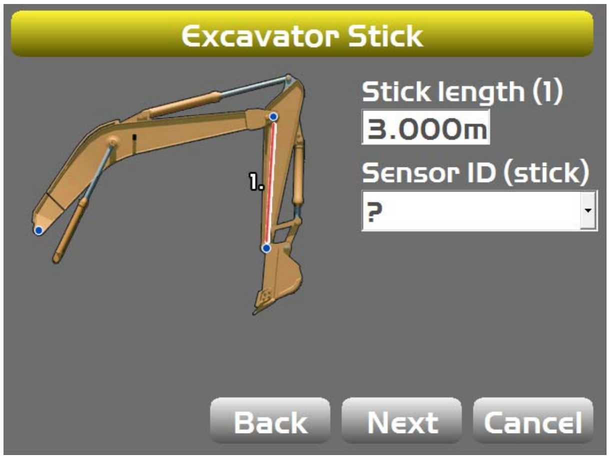


Figure 23: Select Stick Sensor ID

12. Repeat step 8 for the stick sensor.
13. Tap **Next** to access the **Bucket Sensor Mounting** screen.

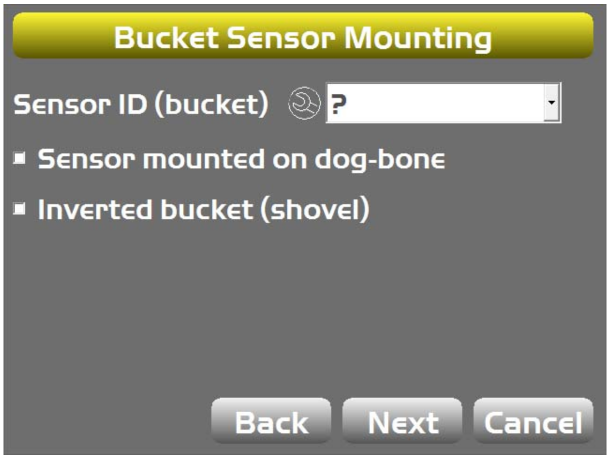


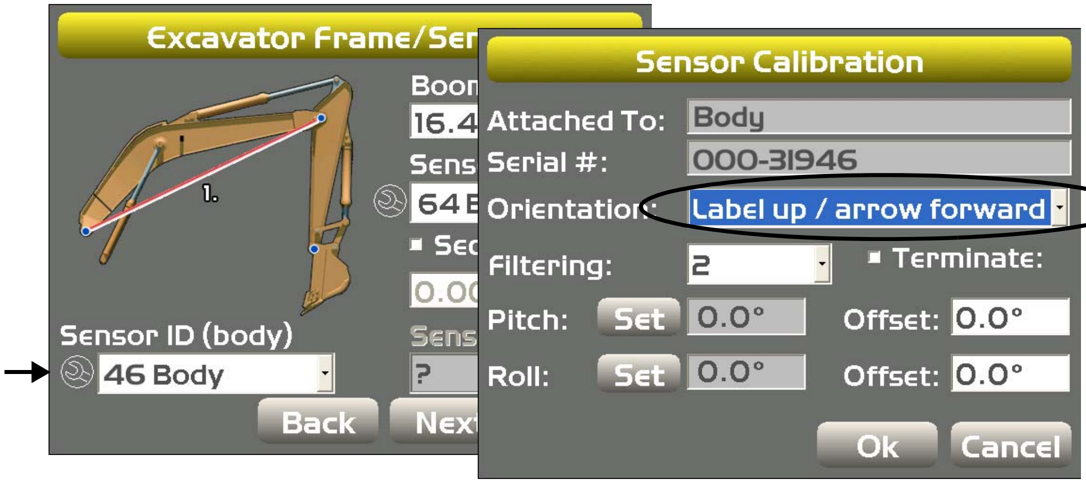
Figure 24: Select Bucket Sensor ID

14. Repeat step 8 for the bucket sensor.

Step 2: Set sensor orientations for the machine elements

1. Navigate to the Excavator Frame/Sensor screen.
2. Tap the **Wrench** icon for the body sensor.

3. Tap the **Orientation** box, and select the physical orientation of the mounted sensor; tap **OK**.



For TS-i3 sensors, **Orientation** will only be left or right.

Figure 25: Select Sensor Orientation

4. Repeat steps 2 and 3 for the remaining boom sensor(s).
5. Tap **Next** and repeat steps 2 and 3 for the stick sensor.
6. Tap **Next** and repeat steps 2 and 3 for the bucket sensor.

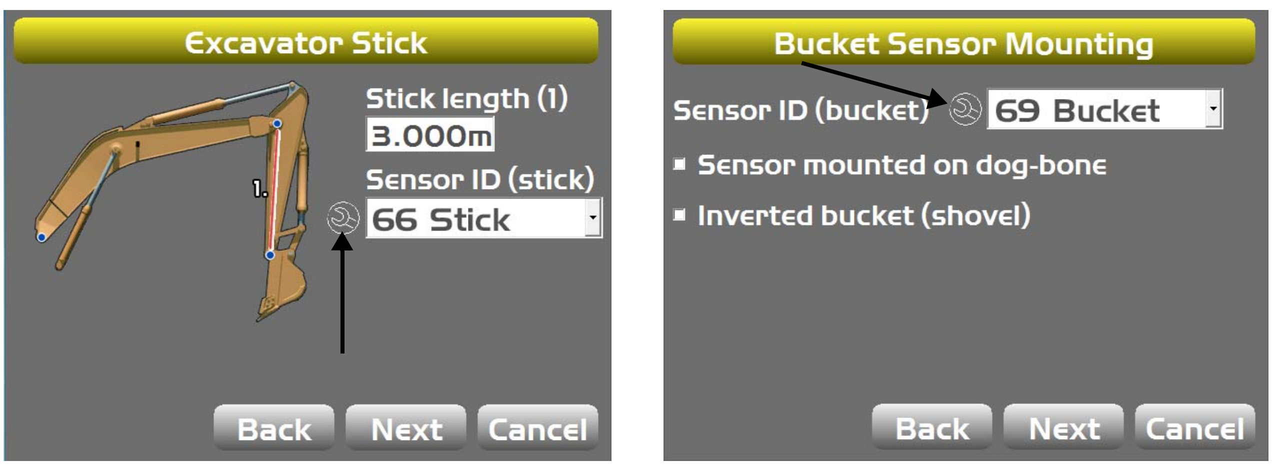


Figure 26: Enter Sensor Orientation

Calibrating the Sensors

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

The best practice is to perform the machine calibrations as ordered in this manual. Performing the calibrations out of order will not affect system performance. The exception to this is when using a dog-bone sensor. You must calibrate the stick sensor before calibrating the dog-bone sensor.

Body Sensor Calibration

The body sensor calibration requires both the pitch and roll calibrations. Perform both calibrations at the same time to ensure accurate measurements.

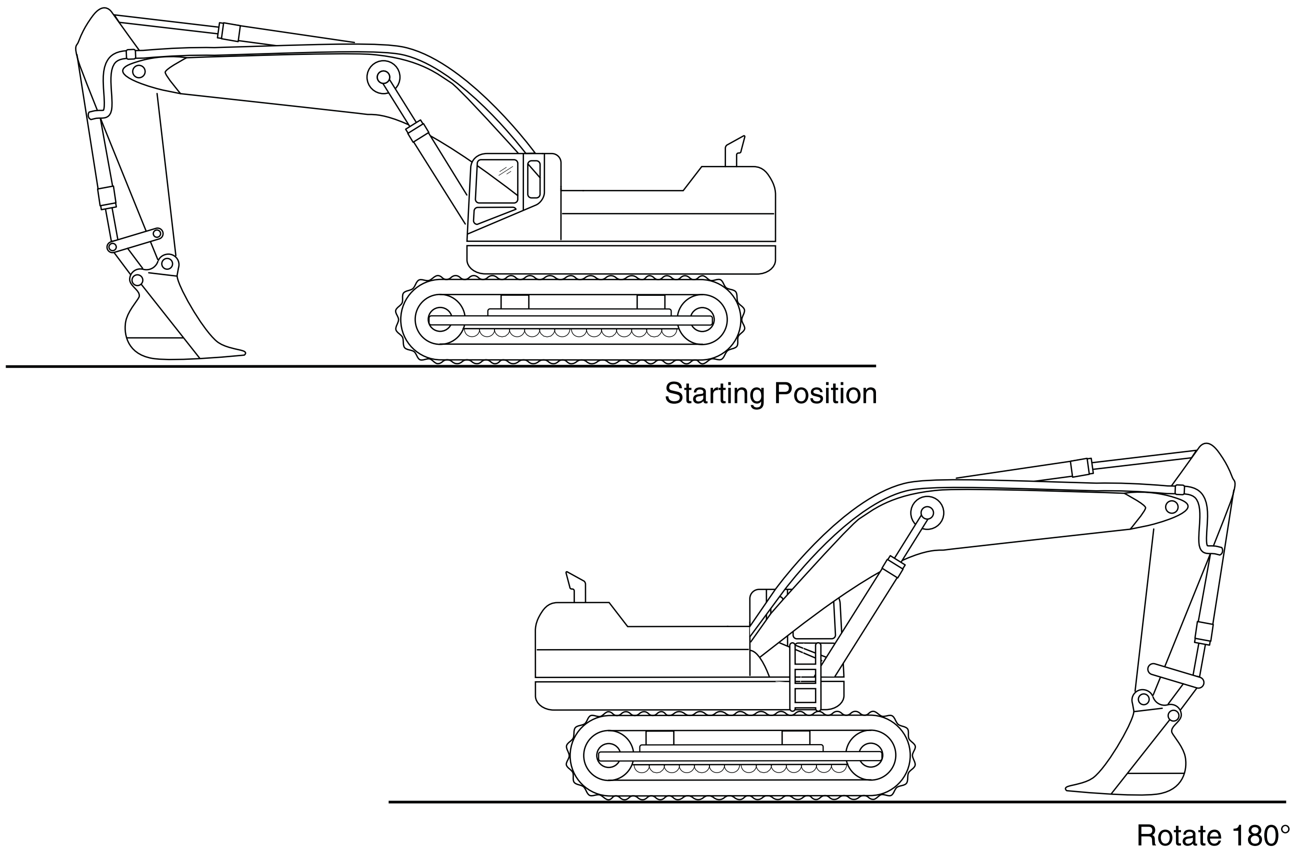


Figure 27: Body Calibrations for Latitudinal Slope

1. Position the machine on a flat and stable surface, free of obstructions.
2. Curl the stick and bucket in as close as possible to reduce tipping errors.
3. Rotate the body parallel to the tracks (position 1).
4. In 3D-MC, tap **Topcon Menu Button** ▸ **Control** ▸ **Machine setup**. Select the applicable machine file for the job, and tap **Edit**. Tap **Next** to navigate to the **Excavator Frame/Sensors** screen.
5. Tap the **Wrench** icon that corresponds to the body sensor.

6. Tap **Set** next to **Pitch,** enter the value as zero, and tap **Set** again (Figure 28); repeat for the **Roll** value.

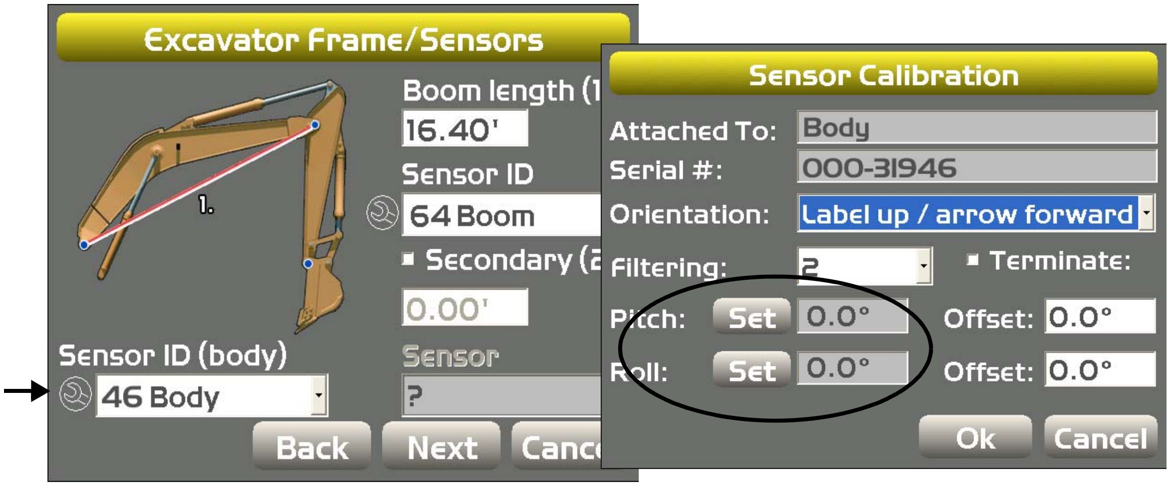


Figure 28: Set Pitch and Roll Values to Zero

7. Without moving the tracks, rotate the machine 180° (position 2).
8. Tap **Set** next to **Pitch**, set the value to half the displayed values, and tap **Set** again (i.e. -5.3/ 2 = -2.65 and -2.8/ 2 = -1.4) (Figure 29); repeat for the **Roll** value, and then tap **OK**.

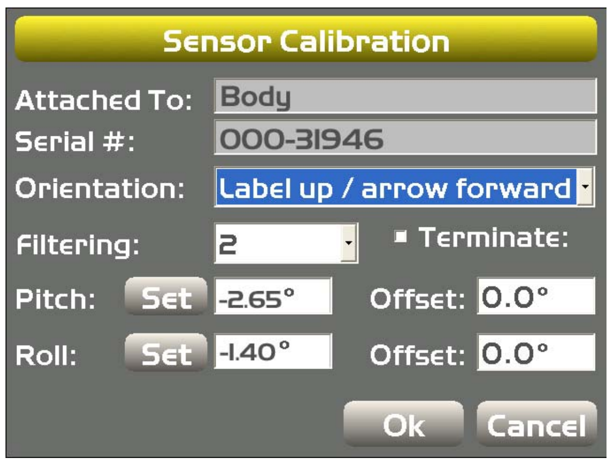


Figure 29: Set Pitch and Roll Value to Half of Displayed Values

9. Check the **Pitch** and **Roll** values in both positions. The two values for each position should be equal, but one will be positive and the other negative.

Once the body sensor roll value is calibrated, record the value somewhere that is accessible for the remainder of the calibration process. As long as the body pitch and roll does not change, this value can be entered for all other sensor roll values. If the body pitch and roll values change (i.e. the machine tracks are moved or the machine is rotated), the new roll value must be referenced.

Boom Sensor Calibration

The boom sensor calibration requires the **Pitch** and **Roll** calibration. When performing the boom sensor calibration, a laser is recommended to correctly position the boom at zero degrees.

Position the machine on a flat and stable surface free of obstructions, and rotate the body parallel to the tracks.

1. Place a zero slope rotating laser along the side of the machine to shine on both the boom pivot and stick pivot.
2. Adjust the laser height to strike the center of the boom pivot (Figure 30).
3. Move the boom to align the stick pivot with the laser (Figure 30).

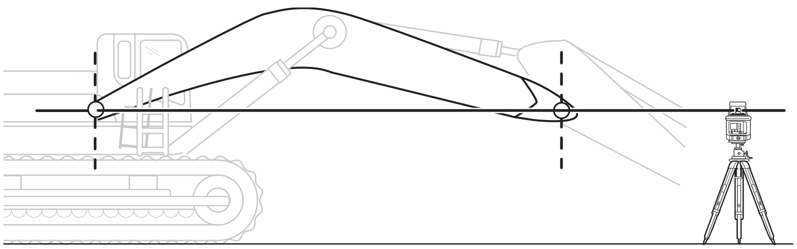


Figure 30: Place Laser to Strike Center of Boom Pivot

4. In 3D-MC, tap **Topcon Menu Button ▸ Control ▸ Machine setup**.
5. Select the applicable machine file for the job and tap **Edit**. Tap **Next** to navigate to the **Excavator Frame/Sensors** screen.
6. Tap the **Wrench** icon that corresponds to the boom sensor (Figure 31).
7. Tap **Set** next to **Pitch**, enter the value as zero, and tap **Set** again (Figure 31).

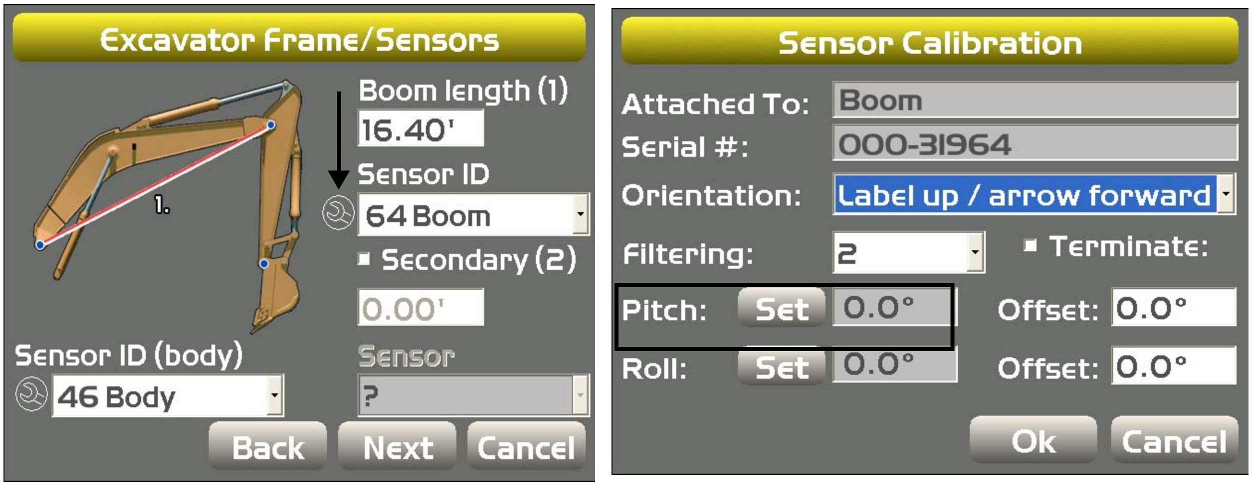


Figure 31: Set Pitch Value to Zero

8. Once the boom pitch value is set to zero, tap **Set** next to **Roll**, set the boom roll value to match the body roll value, and tap **Set** again (Figure 32).

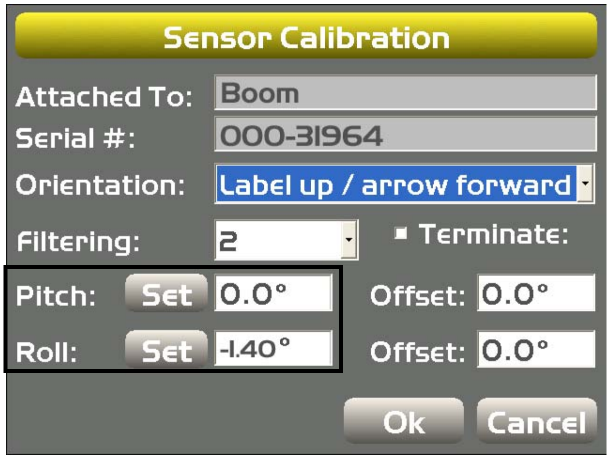


Figure 32: Set Boom Roll Value to Match Body Roll Value

If the body Pitch and Roll has not changed from when the body sensor was calibrated, enter the recorded body Roll value for the boom Roll value. If the body Pitch and Roll has changed, navigate to the body sensor and record the new body Roll value, and enter that new value for the boom Roll value.

9. Tap **OK** to continue.

Secondary Boom Sensor Calibration (Optional)

Like the primary boom sensor, the secondary boom sensor calibration requires both the pitch and the roll calibration. The same method used for calibrating the primary boom sensor is used to calibrate the secondary boom sensor.

Make sure to check the **Secondary Boom** check box (Figure 33). See "Boom Sensor Calibration" on page 27 for details on calibrating the secondary boom sensor.

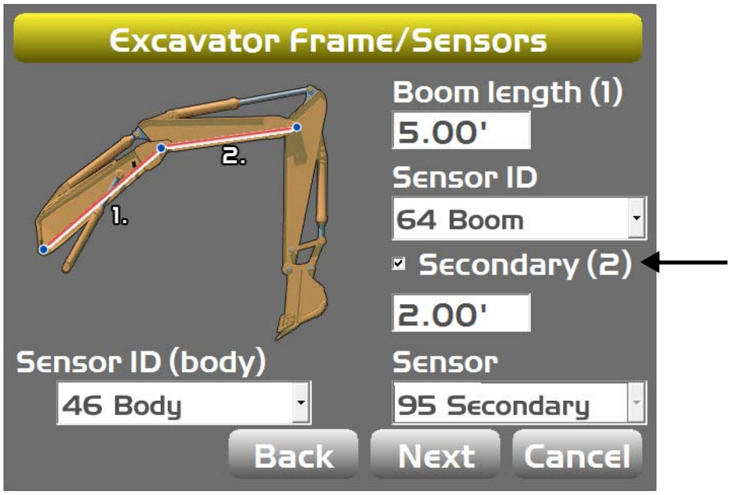


Figure 33: Secondary Boom Check Box

Stick Sensor Calibration

The stick sensor calibration requires both the pitch and the roll calibration. When performing the stick sensor calibration position the stick at -90 degrees.

Position the machine on a stable surface free of obstructions and rotate the body parallel to the tracks.

1. Position the stick at -90° (Figure 34 on page 29).
2. Align the boom-stick pivot and the bucket pivot.

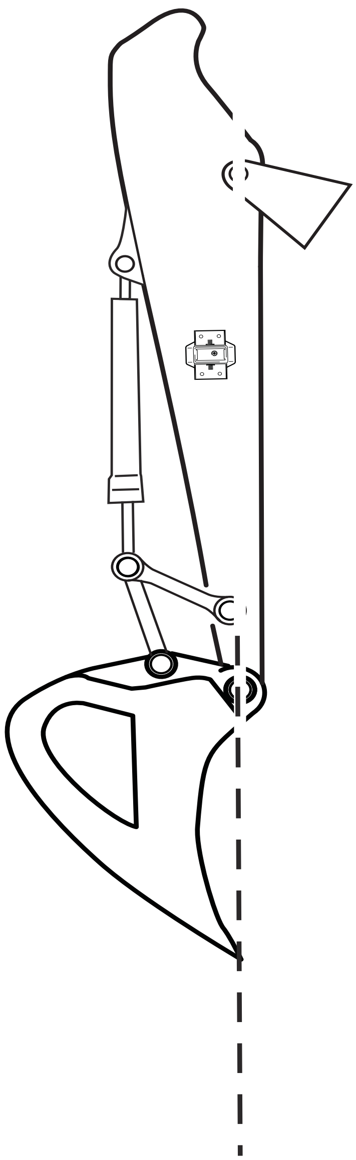


Figure 34: Stick at -90°

3. In 3D-MC, tap **Topcon Menu Button** ▸ **Control** ▸ **Machine setup**. Select the applicable machine file for the job and tap **Edit**. Tap **Next** to navigate to the **Excavator Stick** screen.
4. Tap the **Wrench** icon for the stick sensor (Figure 35 on page 30).

5. Tap **Set** next to **Pitch,** enter the **Pitch** value as -90.0°, and tap **Set** again(Figure 35).

Figure 35: Set Pitch Value to -90.0

6. Tap **OK** to continue.
7. To correctly set the **Roll**, move the stick up in the air until the **Pitch** reads zero (0.0°) (Figure 36).

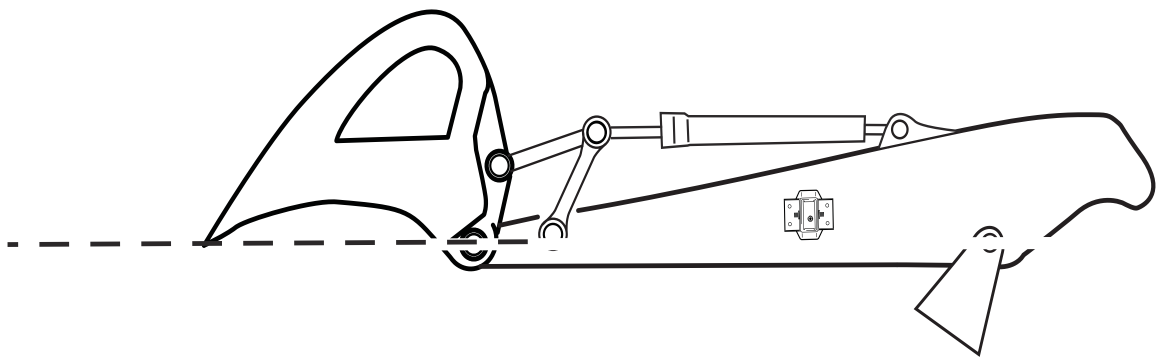


Figure 36: Pitch 0.0°

8. Tap **Set** next to **Roll**, enter the stick roll value to match the body roll value, and tap **Set** again.(Figure 37); tap **OK** to continue.

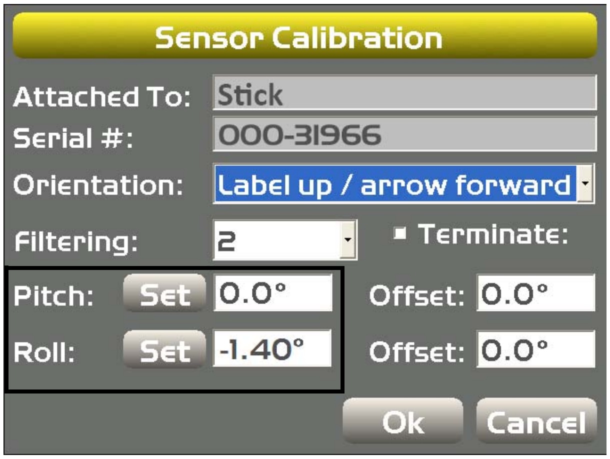


Figure 37: Set Stick Roll Value to Match Body Roll Value

If the body Pitch and Roll values have not changed from when the body sensor was calibrated, enter the recorded body Roll value for the stick Roll value. If the body pitch and roll has changed, navigate to the body sensor and record the new body Roll value, and enter that new value for the stick Roll value.

Bucket Sensor Calibration

There are two options to mount the bucket sensor: directly on the bucket, or mounted on the dog-bone. Because the dog-bone option requires extra steps before calibrating the bucket, this procedure will be discussed first. If mounting the bucket sensor directly on the bucket, skip to "Bucket-Mounted Calibration" on page 34.

Dog-bone Sensor Calibration

The dog-bone sensor calibration requires both the pitch and the roll calibration. When performing the dog-bone sensor calibration, a builder's level is required to correctly position the dog-bone at zero degrees.

The dog-bone calibration compares the stick sensor to the dog-bone sensor to determine bucket angle. The stick sensor must be properly calibrated before attempting the dog-bone calibration.

1. Position the machine on a stable surface free of obstructions, and rotate the body parallel to the tracks.
2. In 3D-MC, tap **Topcon Menu Button** ▸ **Control** ▸ **Machine setup**, select the applicable machine file for the job, and tap **Edit**.
3. Tap **Next** to navigate to the **Bucket Sensor Mounting** screen.
4. Tap the **Sensor ID (bucket)** box, and select the serial number of the sensor.
5. Check the **Sensor mounted on dog-bone** check box, and tap **Next (**Figure 38**)**.

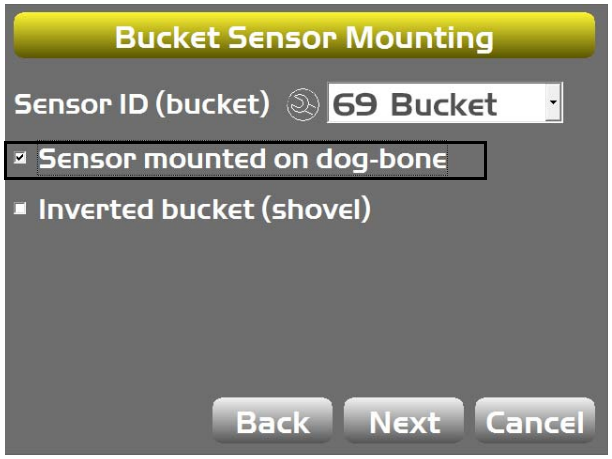
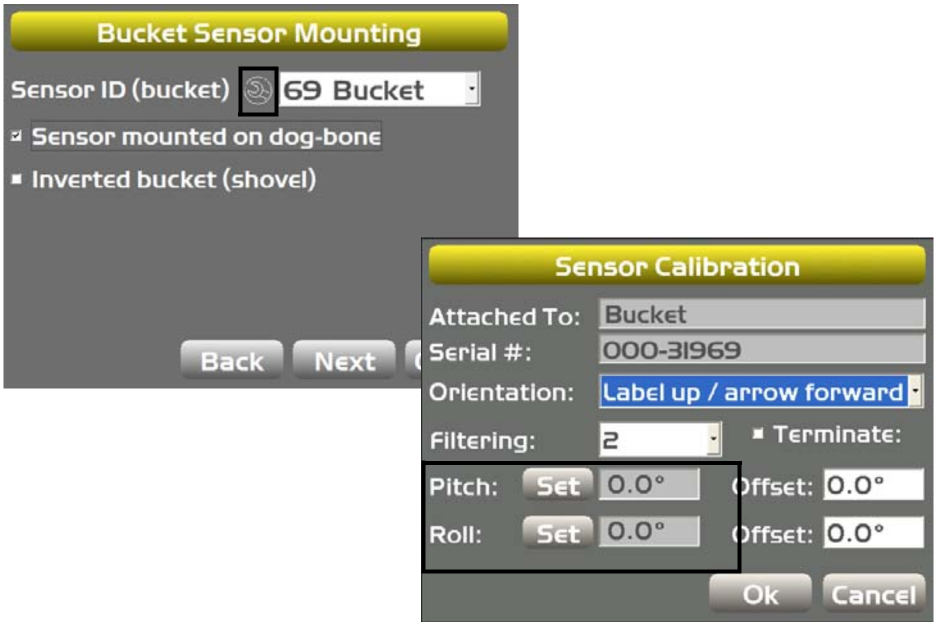


Figure 38: Check Sensor Mounted on Dog-bone.

6. Set the dog-bone (elements 3 and 4) horizontal using a builder's level, and set elements 3 and 2 vertical with either a plumb bob or a survey instrument.
7. Once all elements are level, tap **Set** next to **Pitch**, enter the value, and tap **Set** again.
8. Tap **Set** next to **Roll**, enter the value, and tap **Set** again (Figure 39 on page 32).



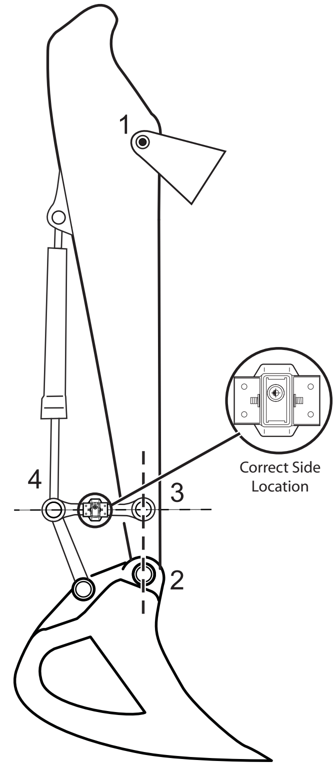


Figure 39: Set Pitch Value to Zero

9. Tap **OK**, and then tap **Next**; the **Excavator DogBone** screen appears (Figure 40).

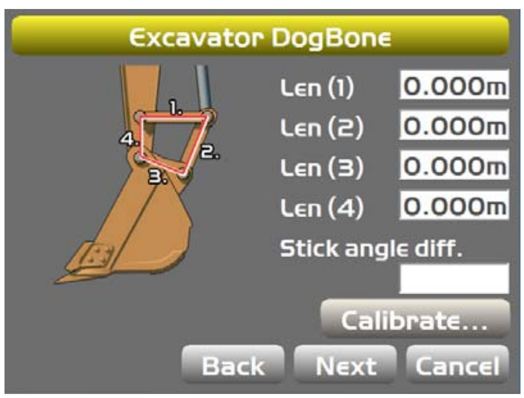


Figure 40: Determine Stick Angle Difference

The dog-bone sensor is normally mounted on the left side, though the **Excavator DogBone** screen depicts the sensor mounted on the right side.

10. Measure and enter the four lengths of the dog-bone joint.
11. Set pins 2 and 3 vertical, and pins 3 and 4 horizontal; the pins can be set using cross hairs in a total station or a builder's level.
12. Tap **Calibrate**; the **DogBone Calibration** screen appears.
13. Enter 90°, and tap **OK**; the **Excavator DogBone** screen appears with a stick angle difference displayed

The dog-bone sensor is normally mounted on the left side, though the **Excavator DogBone** screen depicts the sensor mounted on the right side.

14. If this is the last sensor physically connected to the machine, see “CAN Termination” on page 41.

Bucket Edge Calibration

Perform the following bucket edge calibration procedures for all bucket types. These calibrations must also be performed for each individual bucket when using multiple buckets.

1. Select a bucket from the **Excavator Buckets** screen.
2. With the bucket plumb, tap **Calibrate** from the **Calibrate Bucket Edge** screen (Figure 41); tap **Next** to go to the **Calibrate Bucket Base** screen.

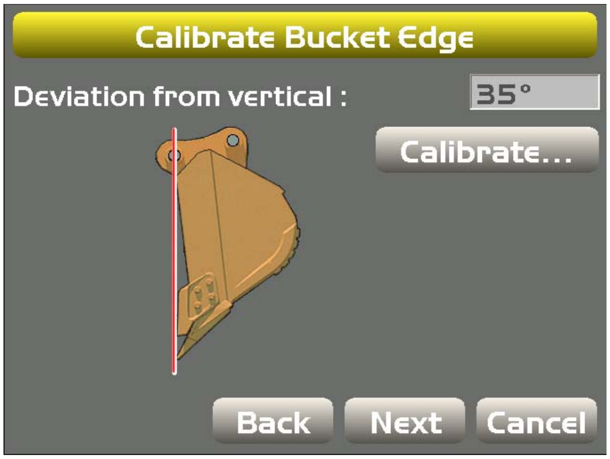


Figure 41: Calibrate Bucket Edge

3. Move the bucket so that the bottom of the bucket lays flat on the ground, and tap **Calibrate**; tap **Finish** to go to the **Excavator Buckets** screen (Figure 42).

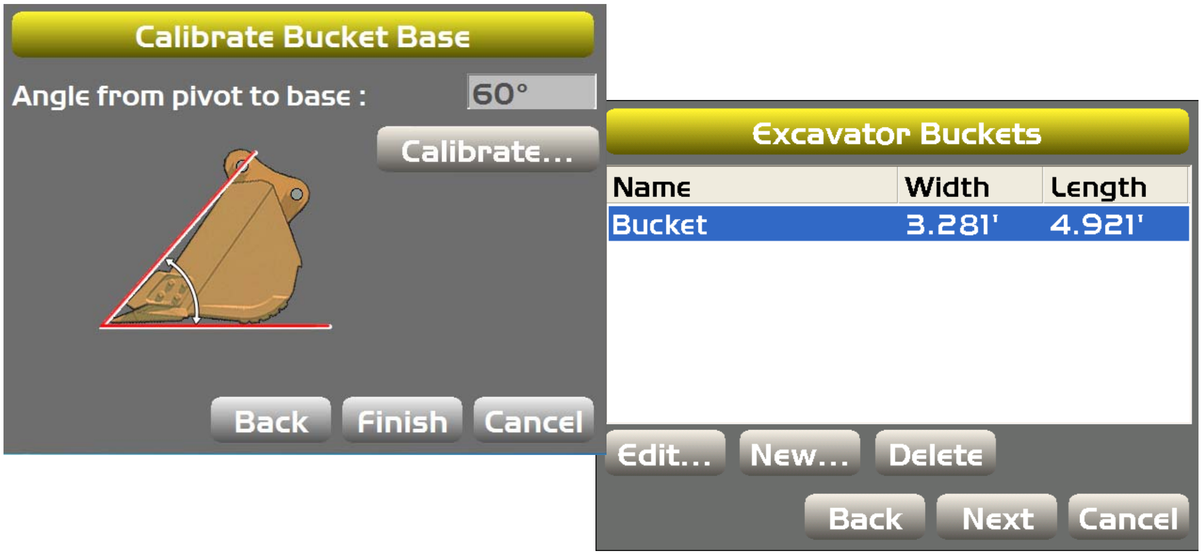


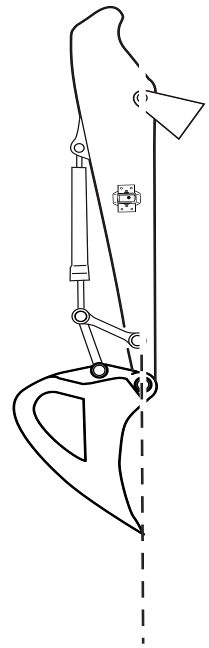
Figure 42: Calibrate Bucket Base

If setting up multiple buckets of any kind, skip to“Multiple Bucket Calibration” on page 37

Bucket-Mounted Calibration

The bucket sensor calibration requires both the pitch and the roll calibration. When performing the bucket sensor calibration, position the bucket at -90° degrees.

If using a tilt bucket sensor, skip to “Tilt Bucket Calibration” on page 37.



1. Align the bucket pivot and the bucket teeth.
2. In 3D-MC, tap **Topcon Menu Button ▸ Control ▸ Machine setup**, select the applicable machine file for the job, and tap **Edit**.
3. Tap **Next** to navigate to the **Bucket Sensor Mounting** screen.
4. Tap the **Wrench** icon for the bucket sensor (Figure 43).
5. Tap **Set** next to **Pitch**, enter the **Pitch** value as -90.0°, and tap **Set** again (Figure 43).

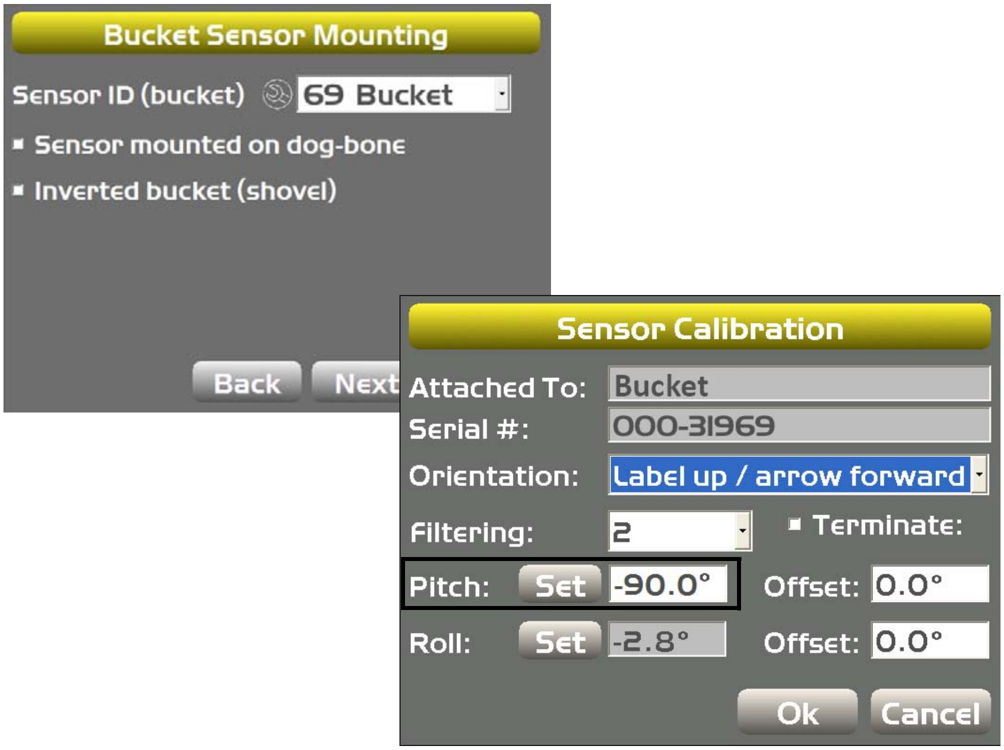


Figure 43: Set the Pitch Value to -90.0°

6. Similar to the stick calibration, once the bucket **Pitch** value is set to -90.0°, move the bucket until the pitch value reads zero (0.0°).

7. Tap **Set** next to **Roll**, enter the bucket roll value to match the body roll value, and tap **Set** again; tap **OK** to continue (Figure 44).

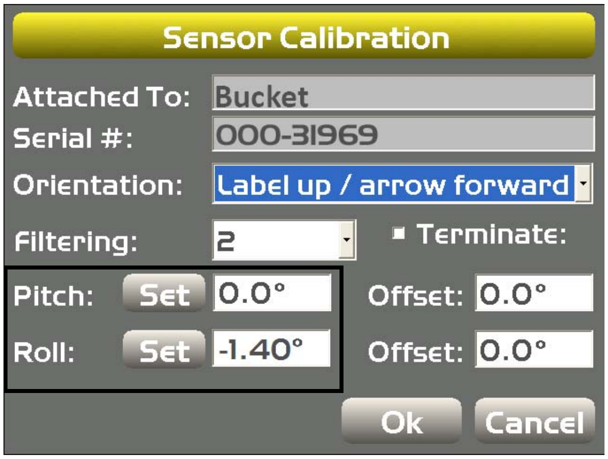


Figure 44: Set Bucket Roll Value to Match Body Roll Value

If the body pitch and roll has not changed from when the body sensor was calibrated, enter the recorded body Roll value for the bucket Roll value. If the body pitch and roll has changed, navigate to the body sensor and record the new body Roll value, and enter that new value for the bucket Roll value.

8. If this is the last sensor physically connected to the machine, see “CAN Termination” on page 41.

Bucket Edge Calibration

Perform the following bucket edge calibration procedures for all bucket types. These calibrations must also be performed for each individual bucket when using multiple buckets.

1. Select a bucket from the **Excavator Buckets** screen.
2. With the bucket plumb, tap **Calibrate** from the **Calibrate Bucket Edge** screen (Figure 45); tap **Next** to go to the **Calibrate Bucket Base** screen.

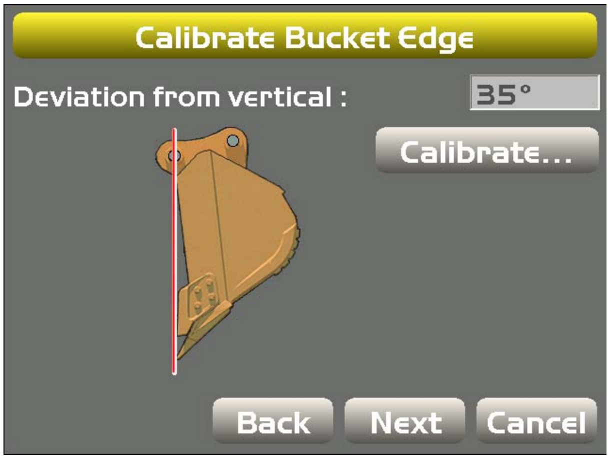


Figure 45: Calibrate Bucket Edge

3. Move the bucket so that the bottom of the bucket lays flat on the ground, and tap **Calibrate**; tap **Finish** to go to the **Excavator Buckets** screen (Figure 46).

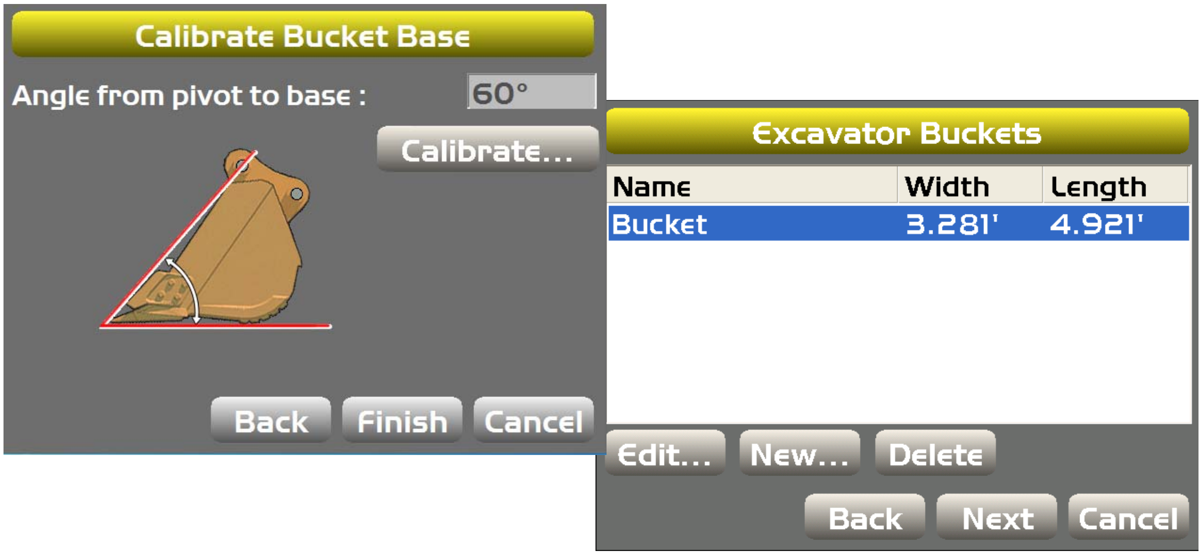


Figure 46: Calibrate Bucket Base

If setting up multiple buckets of any kind, skip to"Multiple Bucket Calibration" on page 37

Multiple Bucket Calibration

If a using a quick coupler to switch buckets, mount the sensor to the quick release mechanism, not the bucket. The geometry of each bucket must then be determined and can be saved in the **Excavator Buckets** screen. When calibrating multiple buckets, you must perform the vertical and flat bucket calibrations for each bucket; see “Bucket Edge Calibration” on page 40.

The process for calibrating multiple buckets is the same as that described in “Bucket Sensor Calibration” on page 31.

When using a quick coupler, only the geometry difference between buckets must be calculated. The calibration process as described in “Bucket Sensor Calibration” on page 31 will remain the same for the sensor.

If setting up a tilt bucket, select the Tilt bucket check box, and refer to “Tilt Bucket Calibration” on page 37 for information on calibration the tilt bucket sensor.

Tilt Bucket Calibration

1. In 3D-MC, tap **Topcon Menu Button ▸ Control ▸ Machine setup.** Select the applicable machine file for the job and tap **Edit**. The **Configuration name/type** screen appears (Figure 47).
2. Tap **Next** until you reach the **Excavator Buckets** screen, and then tap **New** (Figure 48).

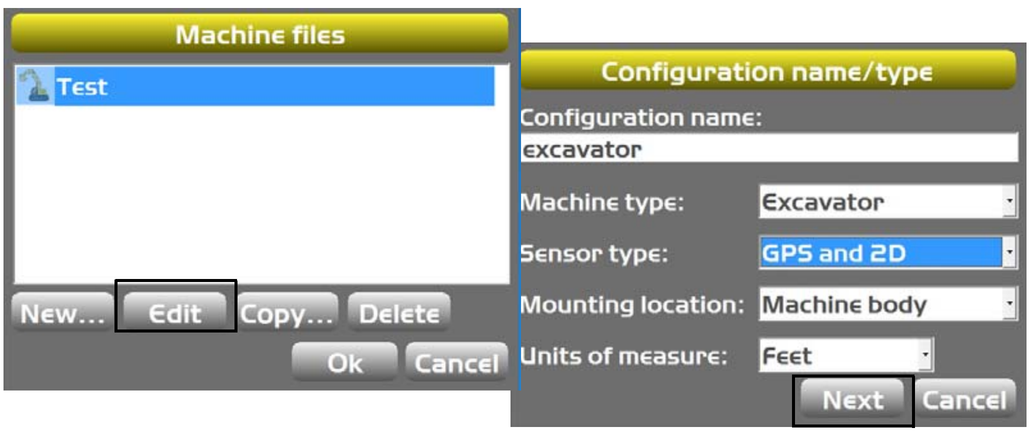


Figure 47: Navigate to Excavator Buckets Screen

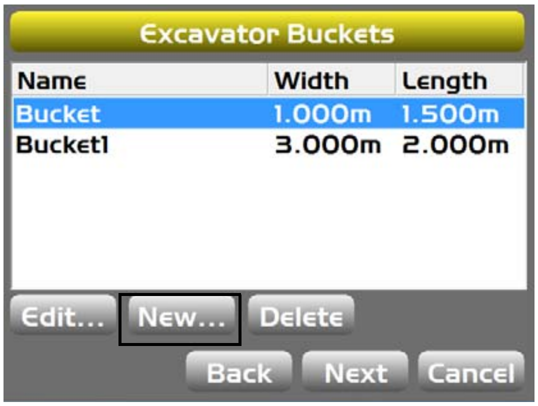


Figure 48: Create New Bucket

3. Enter the bucket **Width** and **Length**, and select the **Tilt bucket** check box (Figure 49).
4. Enter a value for the tilt bucket **Length (3)**, and select a **Sensor ID** for the tilt bucket sensor.

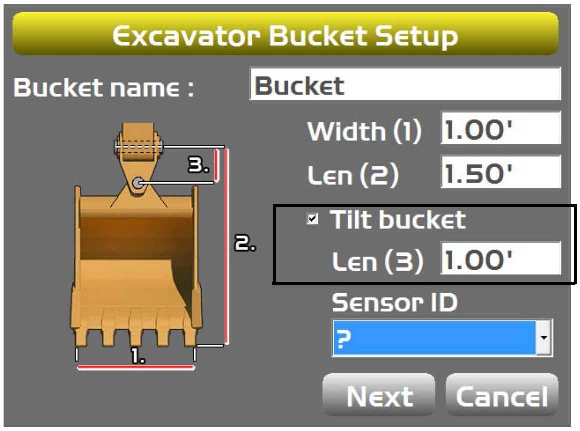


Figure 49: Enter Tilt Bucket Measurements

5. Adjust the bucket until the tilt pin is horizontal.
6. Using a carpenter's level, adjust the cross slope of the bucket until the bucket is level.
7. In 3D-MC, tap the **Wrench** icon next to the **Sensor ID**.
8. Select the sensor's **Orientation** based on this position (Figure 50). Note that TS-i3 sensor orientation is only left and right.

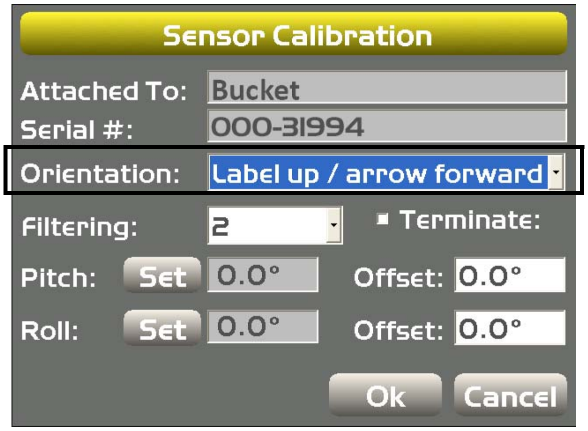


Figure 50: Select Tilt Sensor Orientation

9. With the bucket in this position, tap **Set** next to **Pitch**, enter the **Pitch** value as 0.0°, and tap **Set** again.
10. Tap **Set** next to **Roll**, enter the **Roll** value as 0.0°, and tap **Set** again (Figure 51).

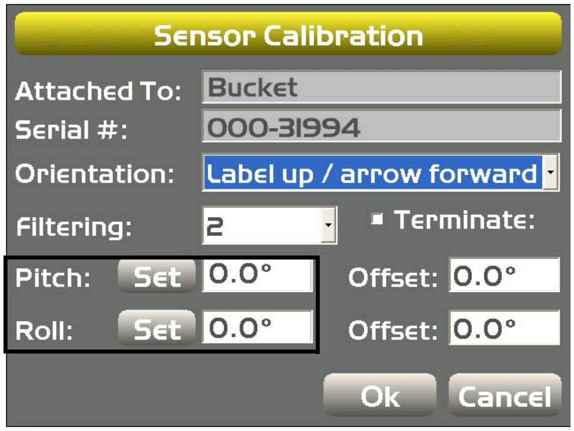


Figure 51: Set Pitch and Roll to Zero

11. Tap **OK**; the **Excavator Bucket Setup** screen appears (Figure 52).

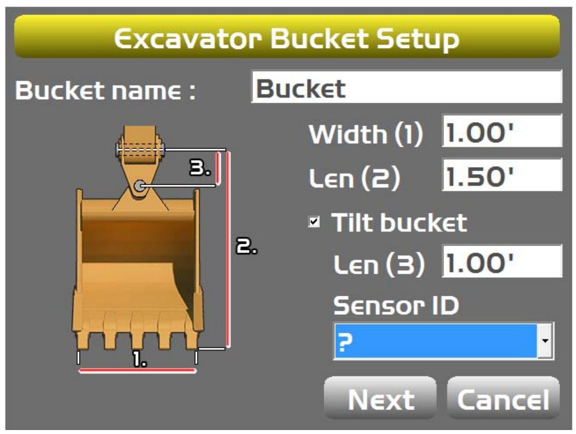


Figure 52: Bucket Setup

12. If this is the last sensor physically connected to the machine, see “CAN Termination” on page 41.

To calibrate the bucket edge, see “Bucket Edge Calibration” on page 35. If setting up multiple buckets of any kind, see “Multiple Bucket Calibration” on page 37.

Bucket Edge Calibration

Perform the following bucket edge calibration procedures for all bucket types. These calibrations must also be performed for each individual bucket when using multiple buckets.

1. Select a bucket from the **Excavator Buckets** screen.
2. With the bucket plumb, tap **Calibrate** from the **Calibrate Bucket Edge** screen (Figure 45); tap **Next** to go to the **Calibrate Bucket Base** screen.

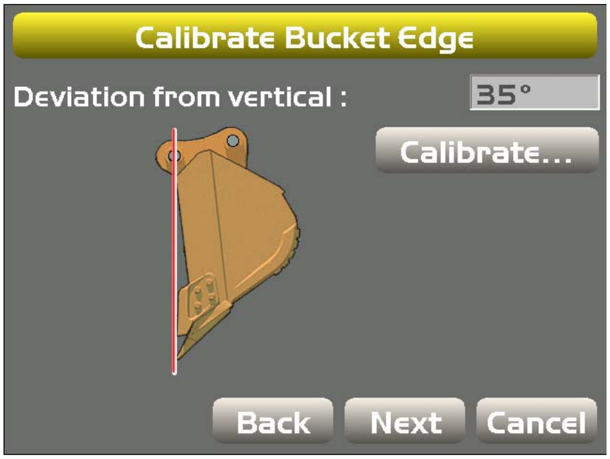


Figure 53: Calibrate Bucket Edge

3. Move the bucket so that the bottom of the bucket lays flat on the ground, and tap **Calibrate**; tap **Finish** to go to the **Excavator Buckets** screen (Figure 46).

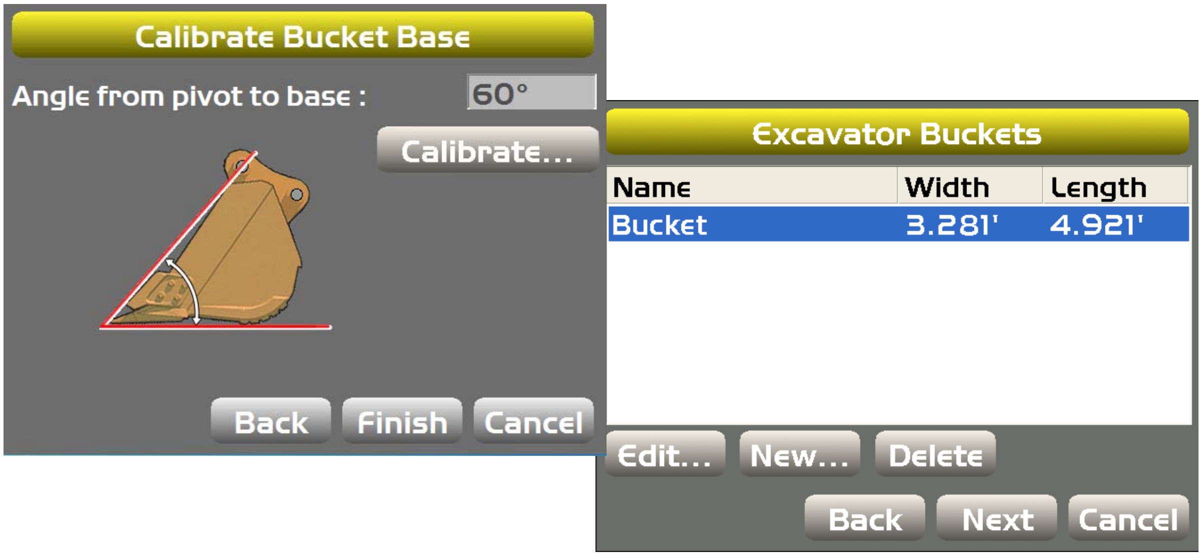


Figure 54: Calibrate Bucket Base

If setting up multiple buckets of any kind, skip to"Multiple Bucket Calibration" on page 37

CAN Termination

To ensure proper communication between the sensors and the control box, the last sensor physically connected must use the hard terminator provided with the excavator systems. Typically, this hard terminator connects to the bucket sensor (or the dog-bone and tilt bucket sensors).

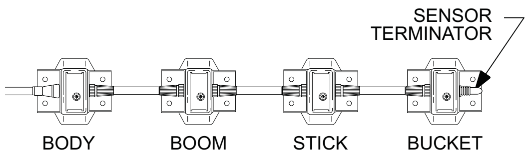


Figure 55: Hard Terminator on Sensor Furthest from the Display

Do not use the 3D-MC software to terminate any sensor. Use only the hard terminator.

Sensor Filtering

The filter level for each sensor can be changed depending on the application and 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. The default filter level is 2. Note that for TS-i3 sensors, orientation will only be left and right.

1. In 3D-MC, tap **Topcon Menu Button** ▸ **Control** ▸ **Machine setup**. Select the applicable machine file and tap **Edit**. Tap **Next** to navigate to the machine element sensor screen.
2. Tap the **Wrench** icon next to **Sensor ID (bucket)** (Figure 56).
3. Select a filtering level and tap **OK** (Figure 56).
4. Navigate through the remaining steps of **Machine Setup**, then save the file and exit 3D-MC.

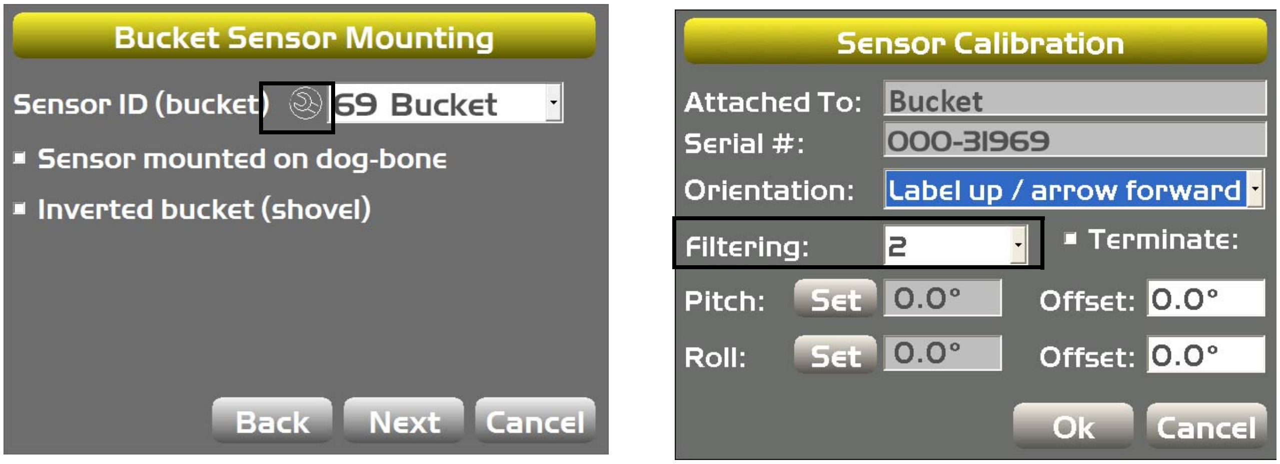


Figure 56: Set Filtering Level (Bucket Sensor)

LS-B10W Laser Receiver Setup

The LS-B10W Laser Receiver adds a laser height reference to the 2D excavator system. The LS-B10W is calibrated for its location on the stick of the excavator. It is not available for X-32 systems.

LS-B10W Mounting

The LS-B10W Laser Receiver and bracket must be mounted on the left side of the stick. The following section describes bracket mounting, cable routing, and LS-B10W Laser Receiver mounting.

A mark on the laser receiver and the cross hairs on the mounting bracket are used to determine its position on the stick. The orientation is selected in the **Laser Receiver (LSB10W) Calibration** screen in 3D-MC.

1. Before installing the LS-B10W bracket, you must assemble the bracket kit; see the *LS-B10W Indexing Bracket Assembly Instructions* (p/n: 7030-1370) for more information.

When determining mounting location, be cautious of limitations in cable lengths.

2. After assembling the bracket, clean the painted surface of the machine’s stick in the area where the bracket will be mounted. Remove the backing from the double-sided tape and mount the bracket onto the stick orientation as shown in Figure 58 on page 43.
3. Install the LS-B10W onto the bracket.
4. Route the cables as shown in Figure 57.

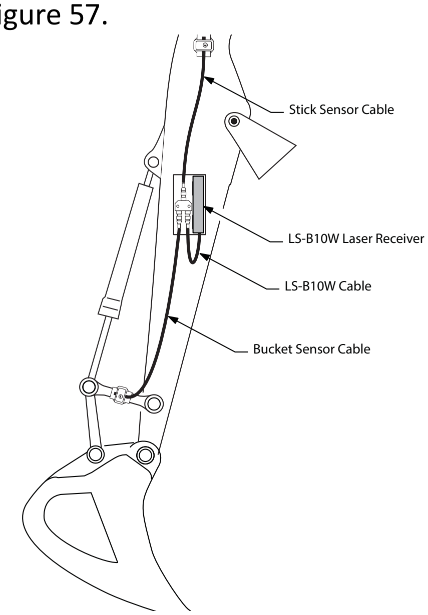


Figure 57: LS-B10W Cable Routing

LS-B10W Calibration

To calibrate the LS-B10W Laser Receiver, determine the position of the receiver on the stick. After calibrating the sensor, 3D-MC will determine the angle of the LS-B10W to the stick center line.

1. Position the machine on a stable surface free of obstructions, and rotate the body to 0.0° roll.
2. Orient the stick so that the LS-B10W is positioned vertically.
3. In 3D-MC, tap **Topcon Menu Button ▸ Control ▸ Machine setup**. Select the applicable machine file for the job and tap **Edit**. Tap **Next** to navigate to the **Laser Receiver (LSB10W)** screen.
4. Enter the following measurements for the LS-B10W (Figure 58).
   - **Depth to center of stick** – enter the measurement for the distance between the middle of the stick to the light cells on the LS-B10W.
   - **From bucket pivot** – enter the measurement for the distance from the along the projected line between the bucket pivot and stick pivot at the point where the LS-B10W is perpendicular to the projected line (Figure 58).
   - **Left of pivot line** – enter the measurement for the distance between the mark on the LS-B10W and the pivot line. If right of pivot line, use a negative value.
5. Make sure the LS-B10W Laser Receiver is vertical, and then tap **Calibrate** to determine the angle between the stick and the LS-B10W (Figure 58).

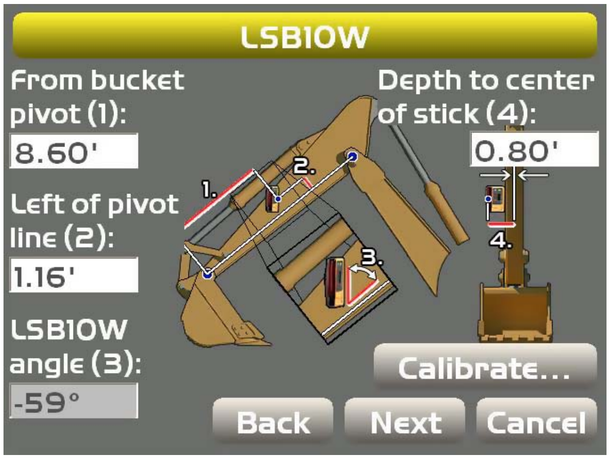


Figure 58: LS-B10W Laser Receiver Measurements

If the stick sensor is replaced with a new tilt sensor, you must recalibrate the LS-B10W Laser Receiver. To test the LS-B10W calibration, see “LS-B10W Test” on page 63.

Installing the Compass

Installing the Drivers (GX-60 Only)

1. Copy the drivers for the USB-Serial adapter to a USB flash drive, and plug the USB flash drive into the GX-60 Control Box; the installation wizard screen appears.
2. Select **Install Hardware Automatically**, and tap **Next**.
3. Choose the drivers to install from the USB flash drive.
4. After installing, navigate to **Control panel** ▸ **System** ▸ **Hardware** ▸ **Device manager** on the GX-60.
5. Tap the **Ports (COM & LPT)** icon to verify which port the USB-to-Serial Bridge is connected to.

Calibrating the Compass

1. In 3D-MC, tap **Topcon Menu Button** ▸ **Control** ▸ **3D/2D Control** ▸ **2D** to place 3D-MC into 2D mode.
2. tap **Topcon Menu Button** ▸ **Control** ▸ **Machine setup...**.
3. On the **Machine Files** screen, select your machine, and tap **Edit**; the **Configuration name/type** screen appears.
4. Tap **Next** until you reach the **Boom / Body (1)** screen.
5. Select **(Serial port)** for the **Compass Type**, and then select the appropriate COM port (Figure 59).

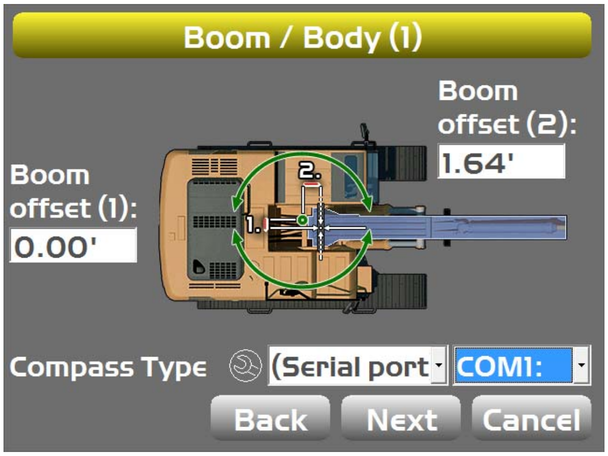


Figure 59: Select the Compass Type and COM Port

6. Tap the **Wrench** icon; the **Calibrate Serial Compass** screen appears.

7. Tap **Start** in 3D-MC, and slowly rotate the compass (Figure 60).

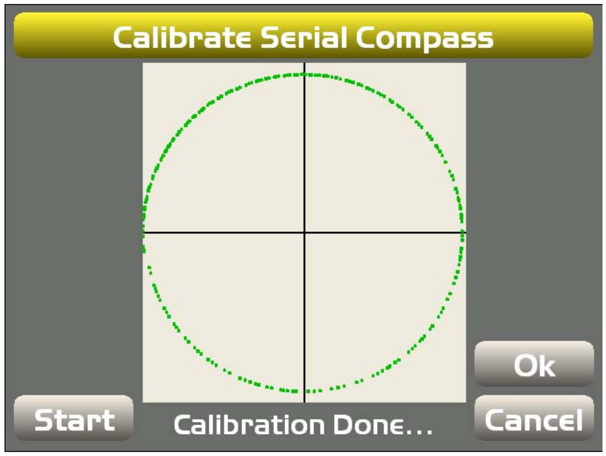


Figure 60: Rotate the Compass and Tap Start

8. Continue rotating to compass until the circle in 3D-MC turns green; calibration of the compass is now done.
9. Navigate through the rest of the machine configuration screens to save your settings.

Activating the Compass

1. Tap **Topcon Menu Button** ▸ **Control** ▸ **Compass Enabled**.
2. Tap **Topcon Menu Button** ▸ **Tools** ▸ **Known Dual Slope...**, and set up the dimensions (Figure 61).

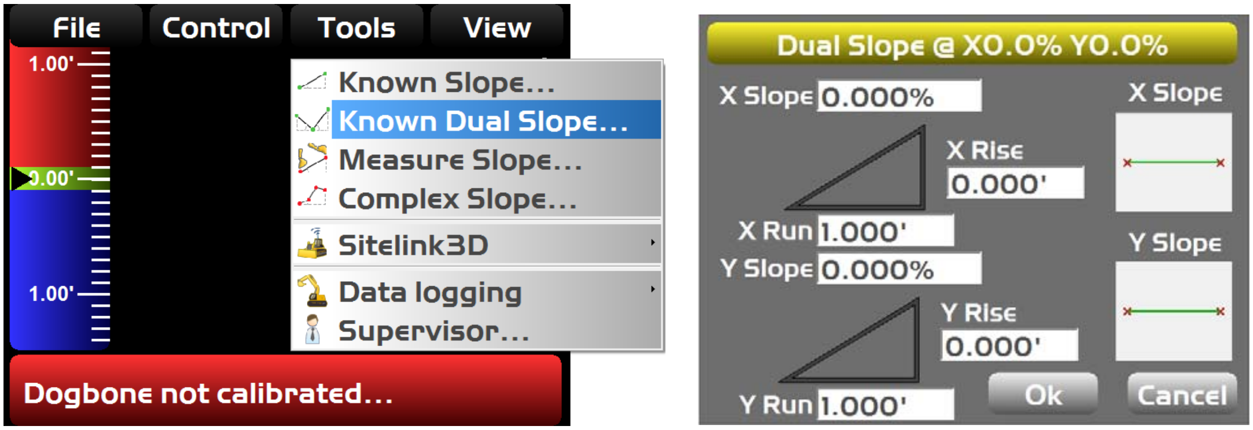


Figure 61: Set the Dual Slope Dimensions

The Compass works for all slopes except Known Slope.

3. Once set, a symbol for the compass appears in 3D-MC (Figure 62).

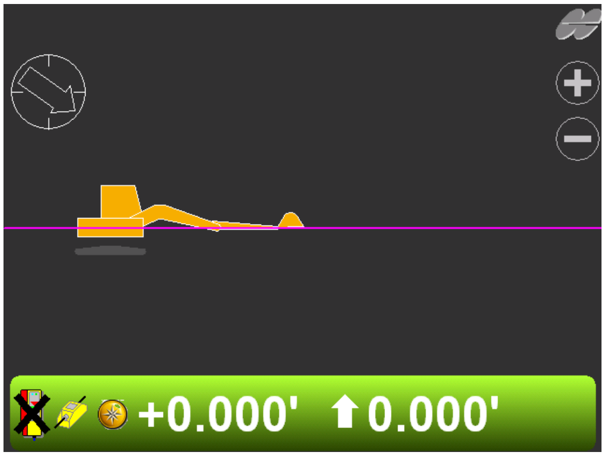


Figure 62: Compass Now Active

Adjusting Calibration

1. Tap the **Elevation Control Key** in 3D-MC; the **Adjust elevation** screen appears.
2. Tap **Zero** for the **Compass**, and then rotate the compass, for example, 90 degrees (Figure 63).

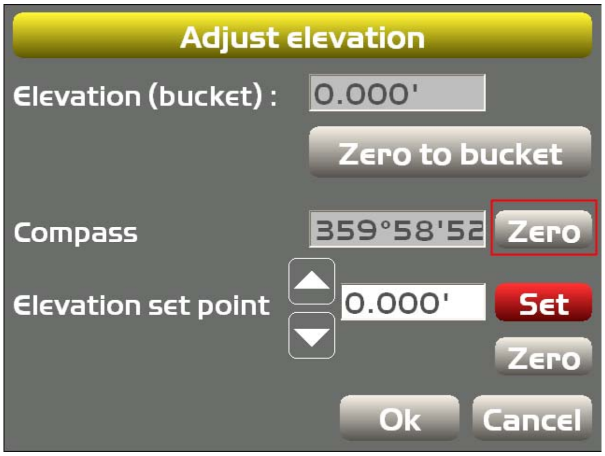


Figure 63: Adjust the Compass Calibration

3. Tap **Set**, and then **OK** to return to the main screen; the **Elevation Control Key** should now reflect your adjustment to the compass (Figure 64).

Figure 64: Elevation Control Key Matches Compass Adjustment

Verifying Setup

After mounting and calibrating the sensors, verify the accuracy of the sensors and the effectiveness of communication with the control box. Occasionally, these same verifications can be performed after several months of use to ensure continued excavating accuracy.

For 2D systems, the sections in this chapter are not necessary as all verification methods use GPS antennas. Therefore, elevations must be verified for 2D systems.

Verifying Range of Motion

Verifying the range of motion via 3D-MC will ensure that all sensors are working and communicating with the GX-60 or the GX-30.

On the **Main** screen of 3D-MC, view a profile and move the various parts of the machine.

- For the body, tilt the machine front-to-back, then left-to-right. The on-screen graphic of the excavator should tilt in the same directions.

It is difficult to roll the excavator. If necessary, move the machine onto a side slope to verify the roll.

For the boom, stick and bucket, slowly move each through as much of the full range of motion as practical. Verify the same movement on the 3D-MC screen.

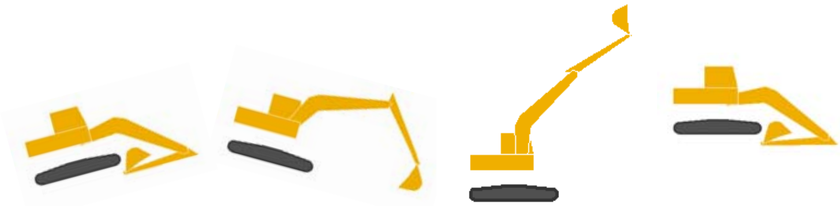


Figure 65: Verify Range of Motion in 3D-MC

If a full range of motion does not occur for the machine image, check the following:

- The correct sensor has been selected for each machine element in 3D-MC.
- The correct orientation has been selected.
- The sensor calibration is correct.
- A sensor has not been selected for more than one location.
- Each sensor is operational.

Navigate to each sensor's calibration screen and check that **Pitch** and **Roll** values are present and change with the machine's movement. If the values are blank, that sensor is not reporting values: either the sensor has not yet been found by the GX-60, or the sensor is not functional.

String Line Verification

Setup

1. Set a Zero Slope using a laser.
2. Set up a string line the length of the machine's reach, and then set up the string level.
3. Ensure that your machine configuration is set up for GPS and 2D in 3D-MC (Figure 66).
4. Tap **Topcon Menu Button ▸ Control ▸ 3D/2D Control ▸ 2D** to place the machine into 2D mode (Figure 66).

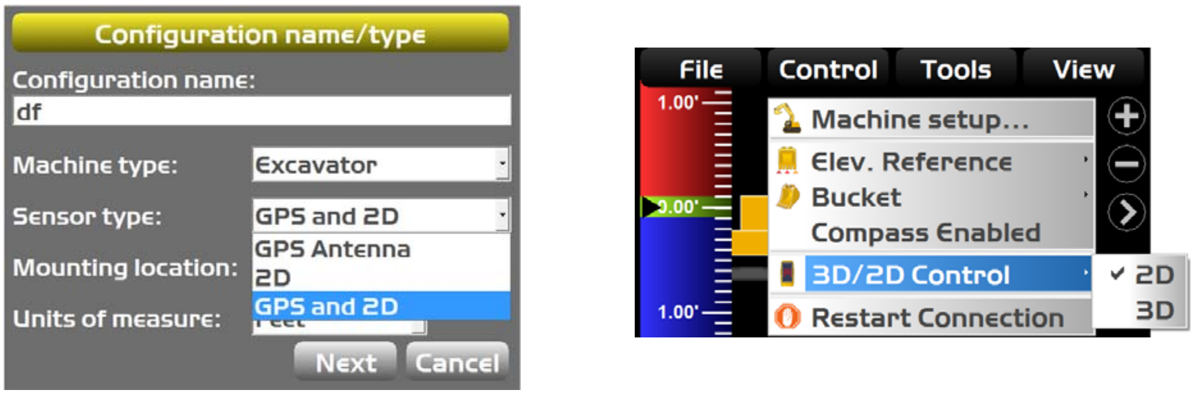


Figure 66: Machine Setup for String Line Verification

5. Create a flat plane surface in 3D-MC.

Test

1. Extend the machine implements so that the bucket is at the far end of the string line.
2. Lower the bucket to the string, and zero the bucket in 3D-MC.
3. Position the bucket on the string at several points, and compare the elevation readings shown in 3D-MC; elevation readings should be zero for each position (Figure 62).

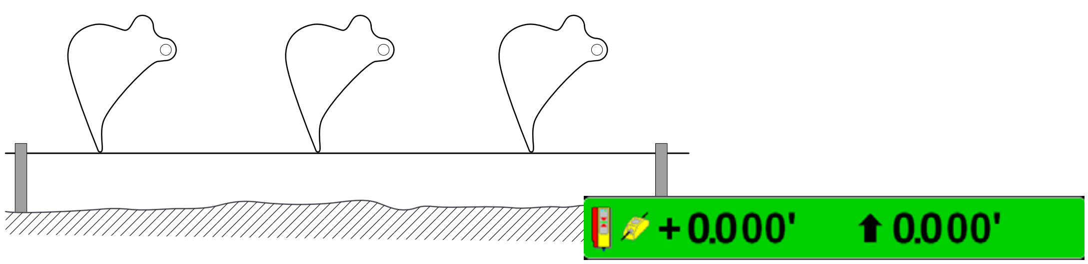


Figure 67: Move the Bucket and Compare 3D-MC Measurements

Reasonable accuracy is within 0.10´. If the machine is well maintained and the measurements made within this guide are precise, accuracy should be even better.

4. If the measurements read zero from point to point, the test is done. If they do not, see "Troubleshooting" on page 49.

Troubleshooting

When troubleshooting, begin with the bucket sensors. If you are unable to determine the problem, proceed with the stick sensor, and then the boom sensor. Note that for the bucket and boom sensors, there are optional secondary sensors that should be checked if they are used. If you are unable to determine the problem after following the procedures below, contact Topcon support.

Troubleshooting the Bucket Sensor

1. Position the bucket above the string line so that the bucket teeth or edge are at their closest point to the string.
2. Place the bucket teeth or edge on the string, and zero the bucket in 3D-MC.
3. Curl only the bucket in and out in various positions, and measure the distance from the string line to the bucket teeth a with measuring tape (Figure 63).

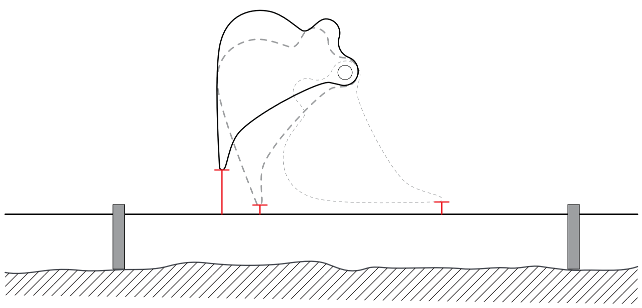


Figure 68: String Line Verification - Bucket

4. Compare the measuring tape values with those shown in 3D-MC.
5. If the measurements compared against 3D-MC match, there could be an issue with one of the other sensors; repeat steps 1-4 and reverify.
6. If the measurements compared against 3D-MC still match, check the tilt bucket sensor (if used), and then follow the steps in "Troubleshooting the Stick Sensor" below.
7. If the measurements compared against 3D-MC do not match, each sensor must be evaluated for machine measurement or calibration errors.

Troubleshooting the Stick Sensor

1. Position the bucket above the string line so that the bucket teeth or edge are at their closest point to the string.
2. Place the bucket teeth or edge on the string, and zero the bucket in 3D-MC.
3. Curl only the stick in and out at various positions, and measure the distance from the string line to the bucket teeth with a measuring tape (Figure 69).

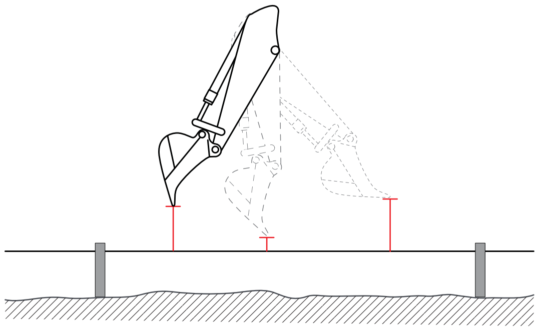


Figure 69: String Line Verification - Stick

4. Compare the measuring tape values with those shown in 3D-MC.
5. If the measurements compared against 3D-MC match, there could be an issue with one of the other sensors; repeat steps 1-4 and reverify.
6. If the measurements compared against 3D-MC still match, follow the steps in "Troubleshooting the Boom Sensor" below.
7. If the measurements compared against 3D-MC do not match, each sensor must be evaluated for machine measurement or calibration errors.

Troubleshooting the Boom Sensor

1. Position the bucket above the string line so that the bucket teeth or edge are at their closest point to the string.
2. Place the bucket teeth or edge on the string, and zero the bucket in 3D-MC.
3. Curl only the boom in and out at various positions, and measure the distance from the string line to the bucket teeth with a measuring tape (Figure 70).

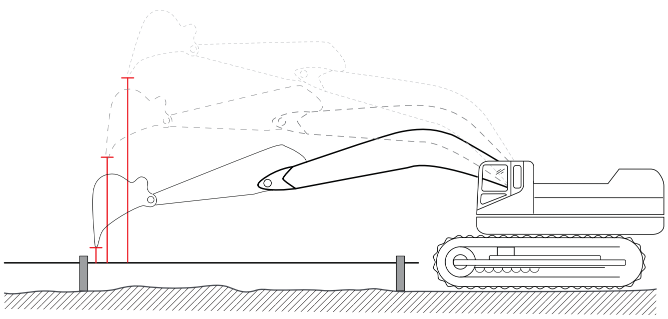


Figure 70: String Line Verification - Boom

4. Compare the measuring tape values with those shown in 3D-MC.
5. If the measurements compared against 3D-MC match, repeat steps 1-4 and reverify.
6. If the values still match, check the secondary boom sensor (if used), and then the body sensor.
7. If the measurements compared against 3D-MC do not match, each sensor must be evaluated for machine measurement or calibration errors.

Verifying Main Antenna-to-Boom Length

The distance from the main antenna to the boom pivot determines the position of the machine front/back. Errors in this measurement will have a direct corresponding position error at the bucket. Use one of the methods below to determine the adjustment needed to account for measurement errors.

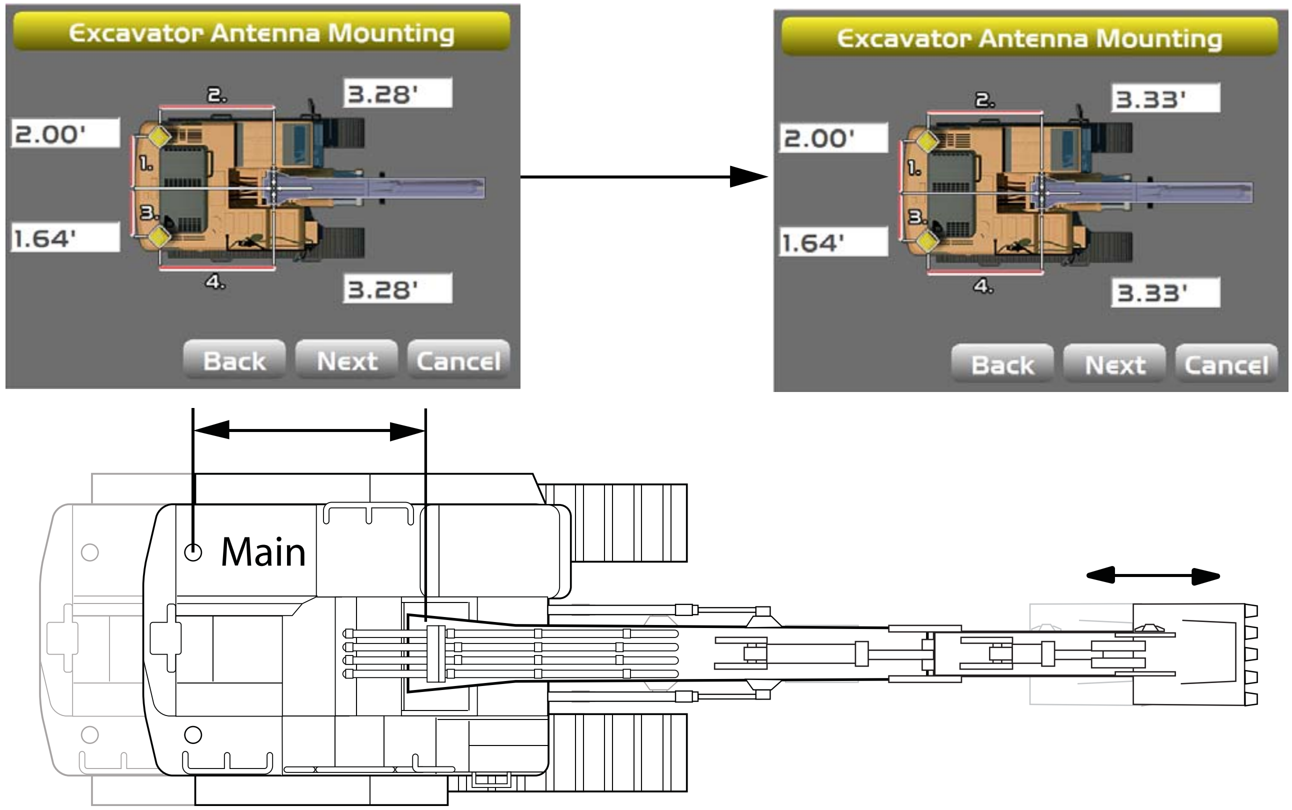


Figure 71: Main Antenna-to-Boom Pivot

Method A: Measure extended positions at 180°

Before you begin, ensure that all equipment and measurements are using the same units of measure (i.e. Meters, Survey Feet, etc.).

Record Measurements:

1. Position the machine on a flat surface.
2. Using 3D-MC as a reference (in a localized project), tap the **Elevation Control Key**, the left **GPS info...** button, and then tap the **Position** tab.
3. Position the machine directly north. Both bucket edges will have the same northing value (Figure 72).

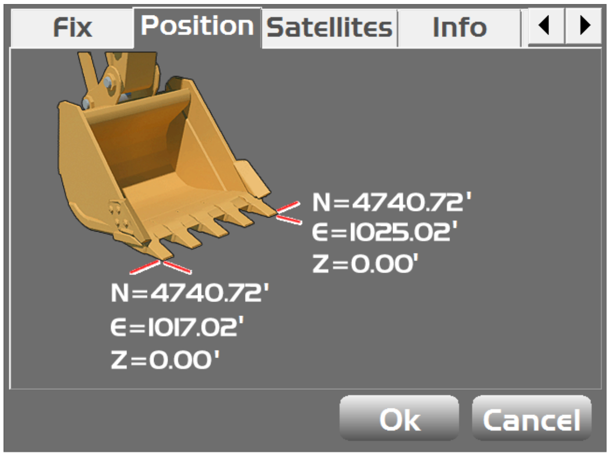


Figure 72: Same Northing Values in 3D-MC

4. Extend the machine elements to their fullest reach, and lower the bucket to the ground.
5. Mark the position of the bucket teeth on the ground, and record the Northing value of one corner of the bucket (e.g. $Northing_N$ = 4740.72).
6. Raise only the boom, and rotate machine body 180° to face directly south.
7. Lower the boom, mark the position of the bucket teeth on the ground, and record the Northing value of the same bucket corner you chose in step 5 (e.g. $Northing_S$ = 4695.22).
8. Calculate the difference between the two [e.g. $Northing_{DIFF}$ = ($Northing_N$ - $Northing_S$) = 45.50].
9. Using a tape measure, measure the distance between the two marks made by the bucket on the ground (e.g. $Measured_{TAPE}$ = 45.30).

Calculate Adjustments:

1. Use the following equation to determine the required adjustment: Adjustment = [(Measured$_{TAPE}$ - Northing$_{DIFF}$) / 2] (see Table 4).
2. Adjust the value in 3D-MC for both the Main and Aux antennas by the calculated amount.
3. Repeat all steps of Method A to verify the correction.

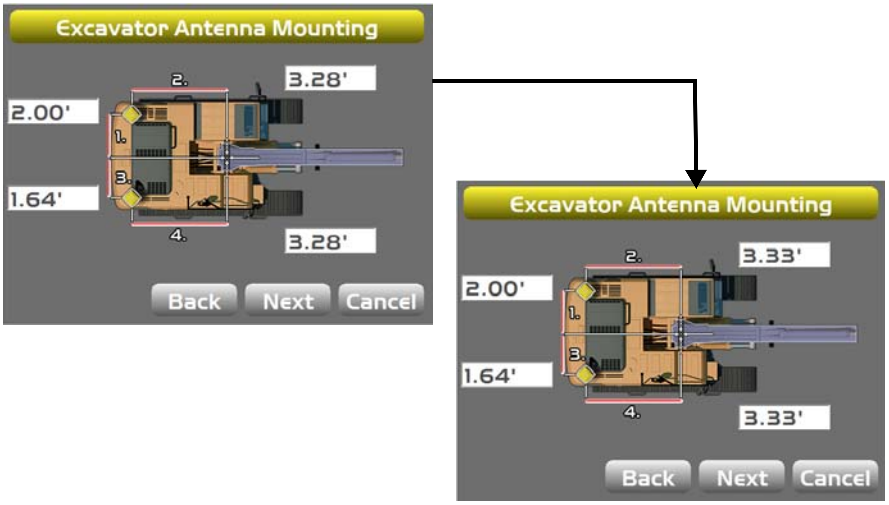


Figure 73: Adjust Main Antenna on Body

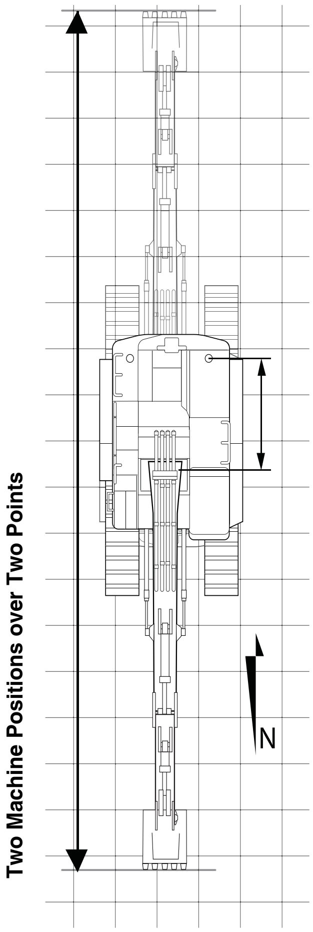


Table 4. Measure Extended Positions Example Calculation

Measurement	Symbol	Value	Adjustment
Northing (Facing North)	Northing$_{N}$	4740.72	
Northing (Facing South)	Northing$_{S}$	4695.22	
Northing Difference	Northing$_{DIFF}$	45.50	
Measured Distance Between Marks	Measured$_{TAPE}$	45.30	
			[(45.30 - 45.50) / 2] = -0.10

Positive adjustments should be added to the 3D-MC values, and negative adjustments should be subtracted.

Failure to adjust the Aux Antenna value will result in a rotational error. Do not physically move the antenna.

Method B: Measuring to a hub at 180°

Before you begin, ensure that all equipment and measurements are using the same units of measure (i.e. Meters, Survey Feet, etc.).

Record Measurements:

1. Position the machine on a flat and stable surface, and place a hub in a flat open area.
2. Using 3D-MC as a reference (in a localized project), tap the **Elevation Control Key**, the left **GPS info...** button, and then tap the **Position** tab.
3. Position the machine directly north. Both bucket edges will have the same Northing value (Figure 72 on page 52).
4. Extend the machine elements to their fullest reach, and lower one bucket corner to the hub.
5. Record the Northing value of one of the bucket corners (e.g. $Northing_N$ = 4720.25).
6. Raise only the boom, move the machine forward beyond the hub, and rotate the machine body 180° to face directly south.
7. Using the same bucket corner chosen in step 5, place the corner on the hub and record the Northing value (e.g. $Northing_S$ = 4720.45).
8. Calculate the difference in Northing values (e.g. $Northing_{DIFF}$ = $Northing_S$ - $Northing_N$ = 0.20).

Calculate Adjustments:

Use the following equation to determine the required adjustment:
Adjustment = [$Northing_{DIFF}$ / 2] (see Table 5).

1. Adjust the value in 3D-MC for both the Main and Aux antennas by the calculated amount.
2. Repeat all steps of Method B to verify the correction.

Table 5. Measure Extended Positions Example Calculation

Measurement	Symbol	Value	Adjustment
Hub Northing (Facing North)	$Northing_N$	4720.25	
Hub Northing (Facing South)	$Northing_S$	4720.45	
Northing Difference	$Northing_{DIFF}$	0.20	
			[0.20 / 2] = 0.10

Positive adjustments should be added to the 3D-MC values, and negative adjustments should be subtracted.

Failure to adjust the Aux Antenna value will result in a rotational error. Do not physically move the antenna.

Verifying Aux Antenna-to-Boom Length

The position of the main antenna to the aux antenna determines GPS heading. The distance from the aux antenna to the boom pivot determines the rotational heading of the machine. Small errors in this measurement may have a significant rotational position error at the bucket. Use one of the methods below to determine the adjustment needed for measurement error correction.

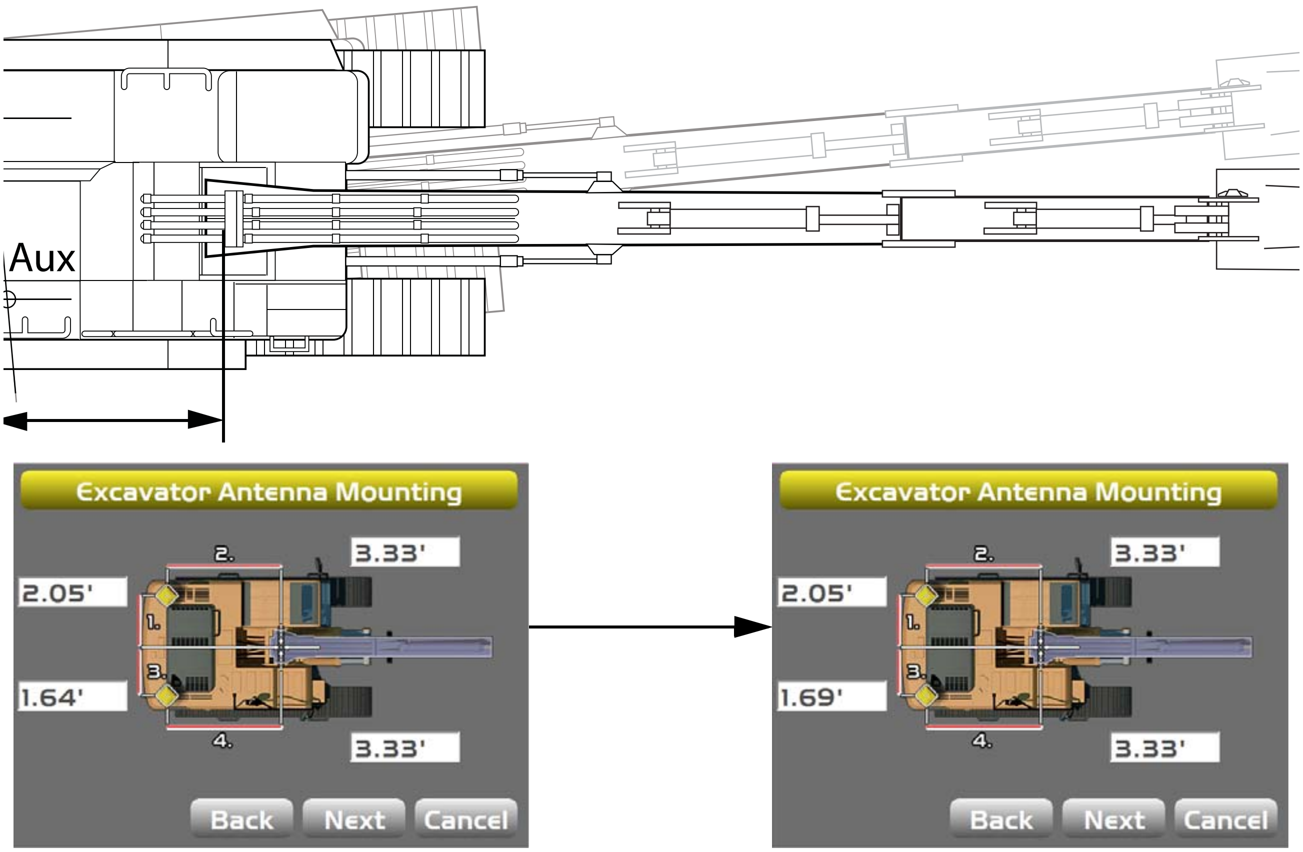
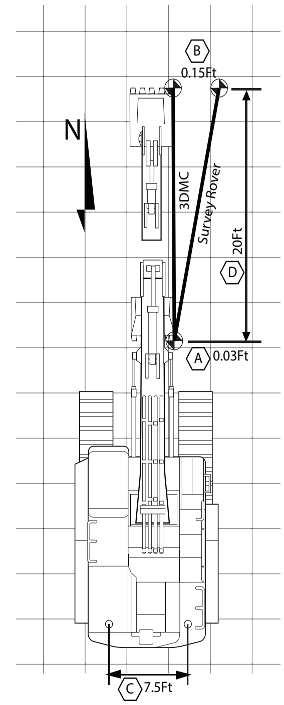


Figure 74: Aux Antenna-to-Boom Pivot

Method A: Using a Survey Rover

Before you begin, ensure that all equipment and measurements are using the same units of measure (i.e. Meters, Survey Feet, etc.). Using the diagram on the right as a reference, record measurements for the bucket curled-in (A), extended (B), the distance between the two antennas (C), and the difference between curled-in and extended (D).



Two Machine Positions over Two Points

Measure with Bucket Curled-in:

1. Position the machine on a flat and stable surface.
2. Using 3D-MC as a reference (in a localized project), tap the **Elevation Control Key**, the left **GPS info...** button, and then tap the **Position** tab.
3. Position the machine directly North (both edges of the bucket will have the same Northing value) (Figure 72 on page 52).
4. Retract the elements and the bucket so that it is curled in near the machine and on the ground. Mark this curled-in position on the ground.
5. Record the Easting value of one corner of the bucket using a survey rover (A_{rover}).
6. Record the Easting value of the same corner with 3D-MC (A_{3DMC}).

Calculate the difference as follows: $A = A_{rover} - A_{3DMC}$

Measure with Bucket Extended:

1. Fully extend the elements and bucket away from the machine so that the bucket is on the ground. Mark this extended position on the ground.
2. Record the Easting value of the same corner of the bucket using a survey rover (B_{rover}).
3. Record the Easting value of the same corner with 3D-MC (B_{3DMC}).
4. Calculate the difference as follows: $B = B_{rover} - B_{3DMC}$

Measure Distances and Calculate Adjustments:

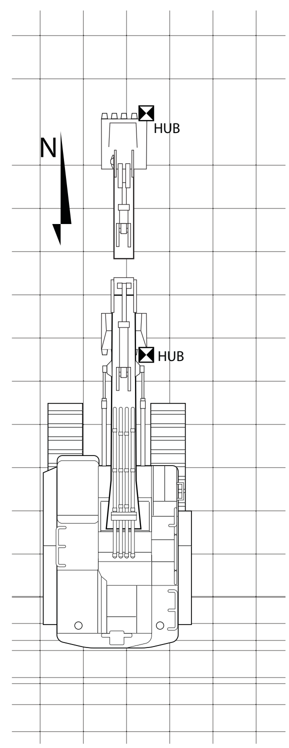
1. Measure the distance between the Main Antenna and the Aux Antenna (C).
2. Use measuring tape to measure the total distance between the curled-in (A) and extended (B) lengths (D).
3. Calculate the adjustment needed for the Aux Antenna-to-Boom length using the following equation: Adjustment = [C * (A - B) / D] (see Table 6 on page 57).
4. Repeat all steps of Method A to verify the correction.

Table 6. Example of Calculations Using a Survey Rover

Measurement	Symbol	Value	Adjustment
Curled-in (Rover)	A_{rover}	520.38	
Curled-in (3DMC)	A_{3DMC}	520.35	
Difference (Rover - 3DMC)	A	0.03	
Extended (Rover)	B_{rover}	520.51	
Extended (3DMC)	B_{3DMC}	520.36	
Difference (Rover - 3DMC)	B	0.15	
Distance Between Antennas	C	7.5	
Distance Between A and B	D	20.0	
			[7.5 * (0.03 - 0.15) / 20] = 0.045

Negative values should be subtracted from the 3D-MC Aux Antenna-to-Boom length measurement, and positive values should be added.

Method B: Without Using a Survey Rover



Before you begin, ensure that all equipment and measurements are using the same units of measure (i.e. Meters, Survey Feet, etc.).

Measure with Bucket Curled-in:

1. Position the machine on a flat surface, and place a hub in a flat open area.
2. Using 3D-MC as a reference (in a localized project), tap the **Elevation Control Key**, the left **GPS info...** button, and then tap the **Position** tab.
3. Position the machine directly north. Both bucket edges will have the same Northing value (Figure 72 on page 52).
4. Retract the elements and bucket so that it is curled-in near the machine, and place a bucket corner on the hub.
5. From 3D-MC, record the Easting value of the bucket corner you chose in step 4 (e.g. $Easting_{CURL}$ = 10425.67).

Measure with Bucket Extended:

1. Fully extend the elements and bucket away from the machine, reposition the machine directly north, and place the bucket on the hub.
2. From 3D-MC, record the Easting value of the previously chosen bucket corner (e.g. $Easting_{EXT}$ = 10425.55).
3. Calculate the difference in Easting values (e.g. $Easting_{DIFF} = Easting_{EXT} - Easting_{CURL} = -0.12$).
4. With the elements extended, measure the distance from the Main Antenna to the bucket teeth on the hub (e.g. $Distance_{Main\text{-}Hub}$ = 30.0).
5. Measure the distance between the Main and Aux antennas (e.g. $Distance_{Main\text{-}Aux}$ = 7.5).
6. Calculate the distance ratio (e.g. $Ratio_{Dist} = Distance_{Main\text{-}Hub} / Distance_{Main\text{-}Aux} = 4$).

Calculate Adjustments:

1. Calculate the adjustment needed in 3D-MC for Aux Antenna-to-Boom length using the following equation:
   Adjustment = [$Easting_{Diff}$ / $Ratio_{Dist}$] (see Table 7).
2. Adjust the value in 3D-MC for the Aux Antenna by the calculated amount. Do not physically move the antenna.
3. Repeat all steps of Method B to verify the correction.

Table 7. Example Calculations without a Survey Rover

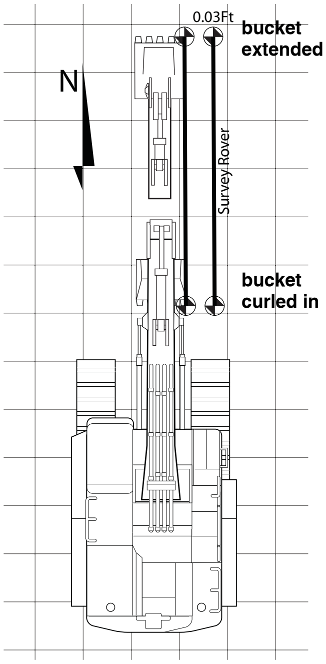
Measurement	Symbol	Value	Adjustment
Easting (Curled-in)	$Easting_{CURL}$	10425.67	
Easting (Extended)	$Easting_{EXT}$	10425.55	
Difference (Extended - Curled)	$Easting_{Diff}$	-0.12	
Distance: Main Antenna to Hub	$Distance_{Main-Hub}$	30.0	
Distance: Main to Aux Antenna	$Distance_{Main-Aux}$	7.5	
			[-0.12 / 4] = -0.03

Negative values should be subtracted from the 3D-MC values, and positive values should be added.

Verifying Antenna-to-Boom Centerline Length

This process is similar to checking the rotational error in the Aux position, but will appear as a constant offset when comparing the curled vs. extended values. Use one of the methods below to determine the adjustment needed for measurement error correction.

Method A: Using a Survey Rover



Before you begin, ensure that all equipment and measurements are using the same units of measure (i.e. Meters, Survey Feet, etc.).

Measure with Bucket Curled-in:

1. Position the machine on a flat surface.
2. Using 3D-MC as a reference (in a localized project), tap the **Elevation Control Key**, the left **GPS info...** button, and then tap the **Position** tab.
3. Position the machine directly north. Both bucket edges will have the same Northing value (Figure 72 on page 52).
4. Retract the elements and the bucket so that it is curled in near the machine and on the ground.
5. Record the Easting value of one bucket corner using a survey rover (e.g. $Easting_{Rover-Curl}$ = 520.38).
6. Record the Easting value of the same corner with 3D-MC (e.g. $Easting_{3DMC-Curl}$ = 520.35).

Measure with Bucket Extended:

1. Fully extend the elements and the bucket away from the machine, with the bucket on the ground.
2. Record the Easting value of the previously chosen bucket corner using a survey rover (e.g. $\text{Easting}_{\text{Rover-Ext}}$ = 520.51).
3. Record the Easting value of the same corner with 3D-MC (e.g. $\text{Easting}_{\text{3DMC-Ext}}$ = 520.48).

Calculate Adjustments:

1. Calculate the adjustment needed in 3D-MC for the Main Antenna-to-Boom Centerline length using the following equation: Adjustment = [$\text{Easting}_{\text{Rover}}$ - $\text{Easting}_{\text{3DMC}}$]. Use this adjustment calculation for curled-in and extended positions (see Table 8).
2. Adjust the value in 3D-MC for the Main Antenna-to-Boom Centerline measurement by the calculated amount. Do not physically move the antenna.
   - A positive adjustment should be added to the 3D-MC values (the distance away from the centerline increases).
   - A negative adjustment should be subtracted from the 3D-MC values (the distance away from the centerline decreases).
3. To avoid rotational errors, adjust the 3D-MC values of the Aux Antenna to match those of the Main Antenna in the same direction.
   - A positive adjustment made for the Main Antenna should be subtracted from the 3D-MC values of the Aux Antenna (the distance away from the centerline decreases).
   - A negative adjustment made for the Main Antenna should be added to the 3D-MC values of the Aux Antenna (the distance from the centerline increases.
4. Repeat all steps of Method A to verify the correction.

If there is a difference between the $\text{Adjustment}_{\text{Curl}}$ and the $\text{Adjustment}_{\text{Ext}}$, repeat the steps in “Verifying Aux Antenna-to-Boom Length” on page 55.

Table 8. Example Calculations with a Survey Rover

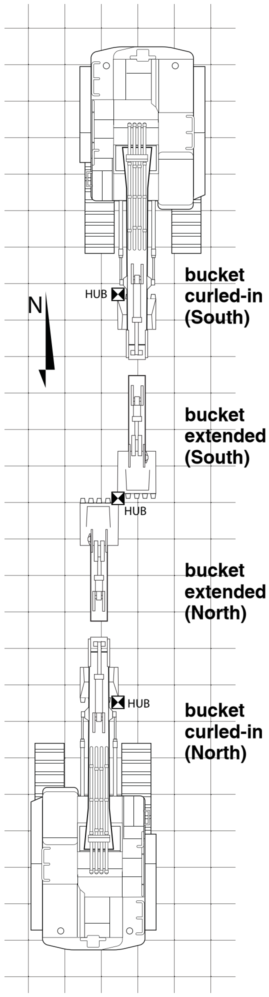
Measurement	Symbol	Value	Adjustment
Curled-in Easting (Rover)	$\text{Easting}_{\text{Rover-Curl}}$	520.38	
Curled-in Easting (3DMC)	$\text{Easting}_{\text{3DMC-Curl}}$	520.35	
Extended Easting (Rover)	$\text{Easting}_{\text{Rover-Ext}}$	520.51	
Extended Easting (3DMC)	$\text{Easting}_{\text{3DMC-Ext}}$	520.48	
Curled Adjustment	$\text{Adjustment}_{\text{Curl}}$		[520.38 - 520.35] = 0.03
Extended Adjustment	$\text{Adjustment}_{\text{Ext}}$		[520.51 - 520.48] = 0.03

Method B: Without Using a Survey Rover

Before you begin, ensure that all equipment and measurements are using the same units of measure (i.e. Meters, Survey Feet, etc.).

Record Measurements:

1. Position the machine on a flat surface, and place a hub in a flat open area.
2. Using 3D-MC as a reference (in a localized project), tap the **Elevation Control Key**, the left **GPS info...** button, and then tap the **Position** tab.
3. Position the machine directly north. Both bucket edges will have the same Northing value (Figure 72 on page 52).
4. Retract the elements and the bucket so that it is curled in near machine, and place a bucket corner on the hub.
5. Record the Easting value of the bucket corner (e.g. $Easting_N$ = 520.35).
6. Raise only the boom, move the machine forward beyond the hub, and rotate the machine body 180° to face directly south.
7. Place the bucket corner chosen in step 4 on the hub and record the Easting value ($Easting_S$ = 520.41).



Two Positions Over Same Hub Facing North Then South

Calculate Adjustments:

1. Calculate the adjustment needed in 3D-MC for the Main Antenna-to-Boom Centerline length using the following equation:
   Adjustment = [($Easting_S$ - $Easting_N$) / 2] (see Table 9).
2. Adjust the value in 3D-MC for the Main Antenna-to-Boom Centerline measurement by the calculated amount. Do not physically move the antenna.
   - A positive adjustment should be added to the 3D-MC values (the distance away from the centerline increases).
   - A negative adjustment should be subtracted from the 3D-MC values (the distance away from the centerline decreases).

3. To avoid rotational errors, adjust the 3D-MC values of the Aux Antenna to match those of the Main Antenna in the same direction.
   - A positive adjustment made for the Main Antenna should be subtracted from the 3D-MC values of the Aux Antenna (the distance away from the centerline decreases).
   - A negative adjustment made for the Main Antenna should be added to the 3D-MC values of the Aux Antenna (the distance from the centerline increases).
4. Repeat all steps of Method B to verify the correction.

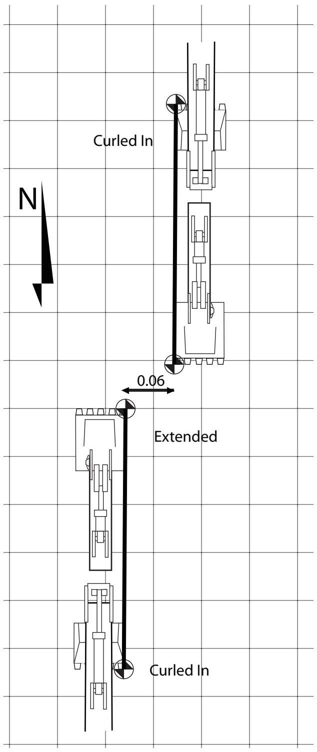


Table 9. Example Calculations without a Survey Rover

Measurement	Symbol	Value	Adjustment
Hub Easting (Facing N)	$Easting_N$	520.35	
Hub Easting (Facing S)	$Easting_S$	520.41	
			[(520.41-520.35) / 2] = 0.03

Verifying Main Antenna Height

The distance from the main antenna to the boom pivot affects the overall elevation 3D-MC calculates for the bucket. If there is an overall bias, the main antenna height can be adjusted.

Record several 3D-MC bucket elevations and corresponding survey rover elevations. Subtract the elevations and find the average.

Table 10. Measure Locations and Determine Difference

Elevations	3D-MC	Rover	Difference
Location 1	101.10	101.17	-0.07
Location 2	120.30	120.36	-0.06
Location 3	99.50	99.58	-0.08
Location 4	114.20	114.26	-0.06
		Average	-0.07

Do not physically adjust the antenna height.

- If the reported average elevations of 3D-MC are higher than a survey rover, increase the antenna height value in 3D-MC.
- If the reported average elevations of 3D-MC are lower than a survey rover, decrease the antenna height value in 3D-MC (Figure 75).

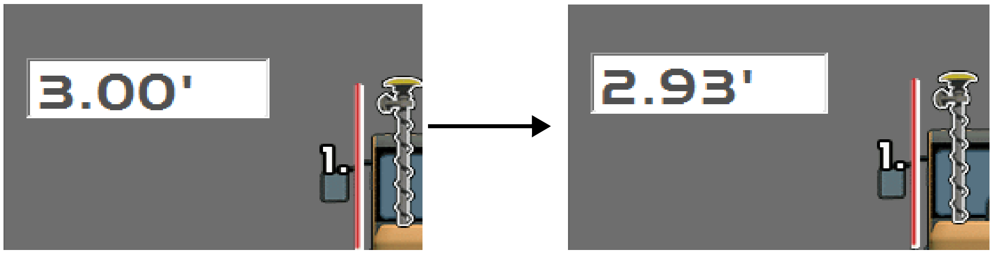


Figure 75: Adjust Main Antenna Height

Verifying Aux Antenna Height

This value is not critical to measuring elevation, so verifying is not required.

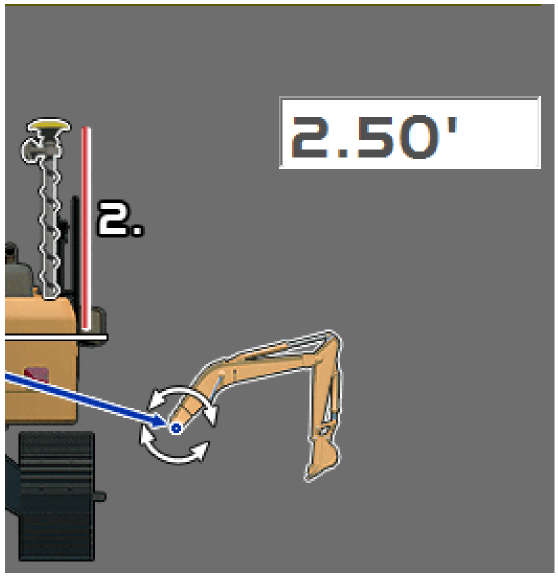


Figure 76: Verifying Aux Antenna Height

The height of the boom pivot simply allows 3D-MC to create a more accurate representation of the machine in the software's graphics. This measurement does not affect elevation accuracy, so verification is not necessary.

Figure 77: Machine Body Size in 3D-MC Graphics

LS-B10W Test

Performing a LS-B10W Laser Receiver test verifies the accuracy of the laser receiver on the machine. The Zero to laser function becomes active in 3D-MC when the laser receiver receives a laser signal.

1. Start 3D-MC.
2. Set up a laser in front of the machine as a reference for the LS-B10W.
3. Set up a string line, or second laser, as a reference to verify the position of the bucket teeth.
4. Measure the offset between the LS-B10W reference laser and the bucket teeth reference laser (e.g. 5.184 Feet).
5. Tap the **Elevation Control Key**.

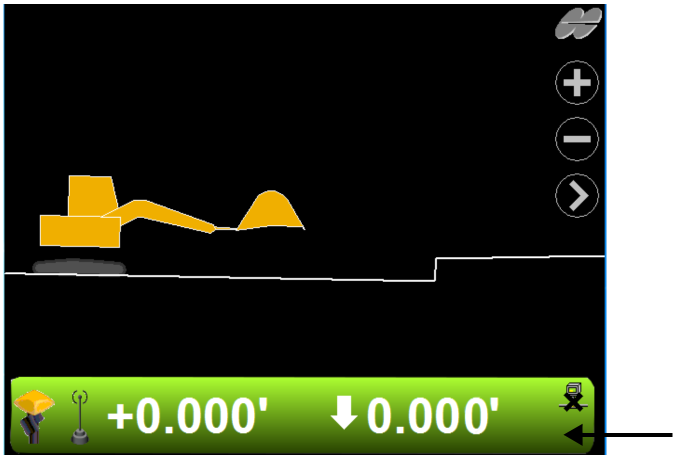


Figure 78: Press Elevation Control Key

6. Enter the offset measurement as the **Elevation set point** in the **Adjust Elevation** control screen (Figure 79).

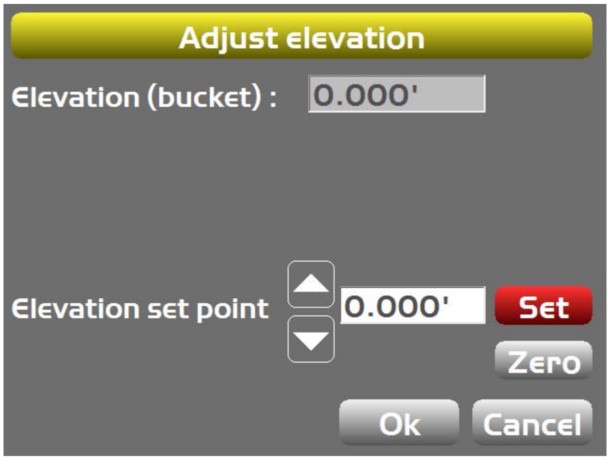


Figure 79: Enter Offset

7. Starting with the LS-B10W above the reference laser height, lower the boom to position the LS-B10W in the laser beam. The **Zero to laser** function becomes available. Tap **Zero to laser** (Figure 80).

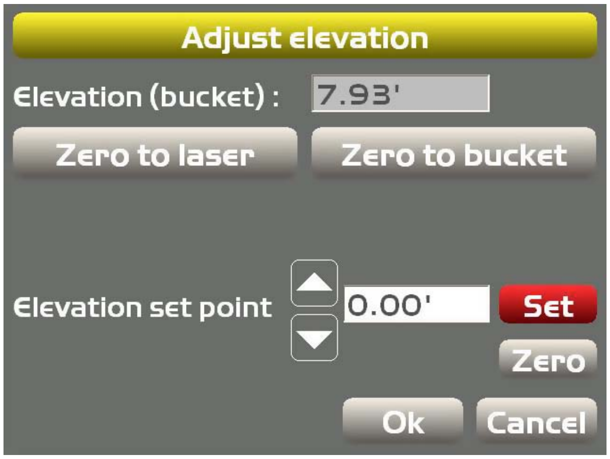


Figure 80: Zero to Laser

8. Place the bucket teeth on the bucket laser reference line and check that the cut/fill value on the main screen is close to 0.00.
9. Starting with the LS-B10W below the reference laser height, raise the boom to position the LS-B10W in the laser beam. The **Zero to laser** function becomes available. Tap **Zero to laser** (Figure 80).
10. Place the bucket teeth on the bucket laser reference line and check that the cut/fill value on the main screen is close to 0.00.
11. Repeat steps 7-10 at various points along the reference line.

Full System Test

Performing a full system test verifies the accuracy of the excavator systems at various machine positions.

If a hub with a known position is available, use it to measure the positions below.

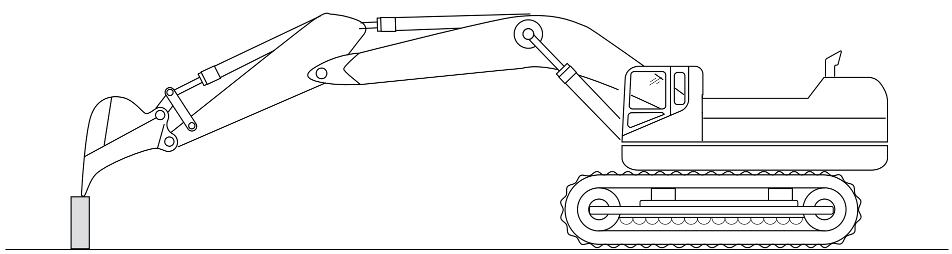
Testing Machine Element Sensors for Accuracy

Testing the sensors on the boom, stick, and bucket requires three bucket measurements at three boom and stick extensions.

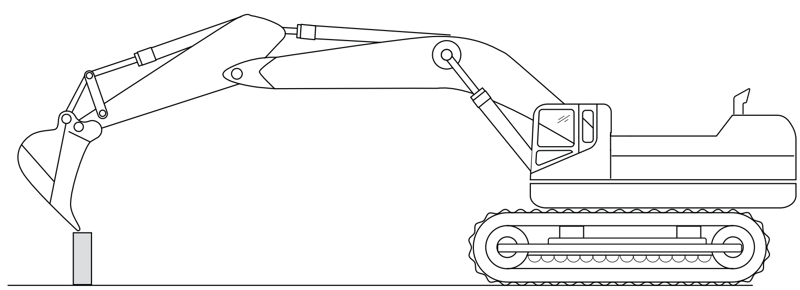
Using a hub, record the local coordinates with the following machine positions facing North, then rotate 180° and record each position again facing South. Use a copy of the table on page 68 to record these points.

Record Bucket Positions with Boom and Stick Fully Extended

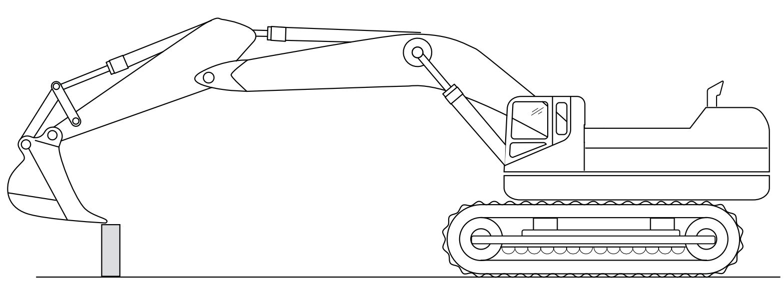
Bucket extended



Bucket mid-position

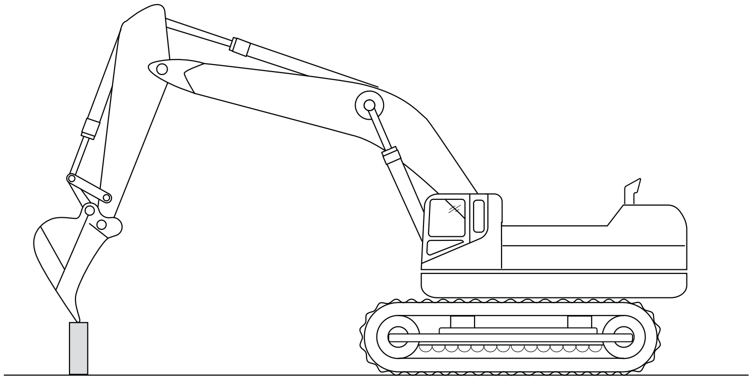


Bucket curled

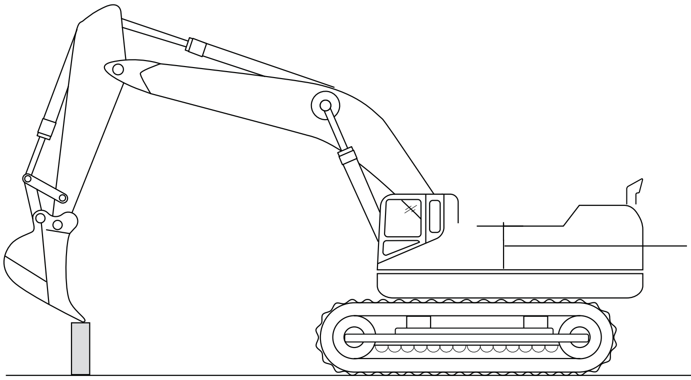


Record Bucket Positions with Boom and Stick in Mid-extension

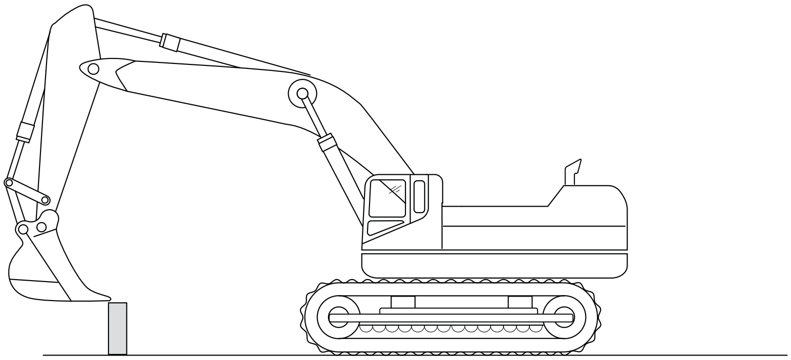
Bucket extended



Bucket mid-position

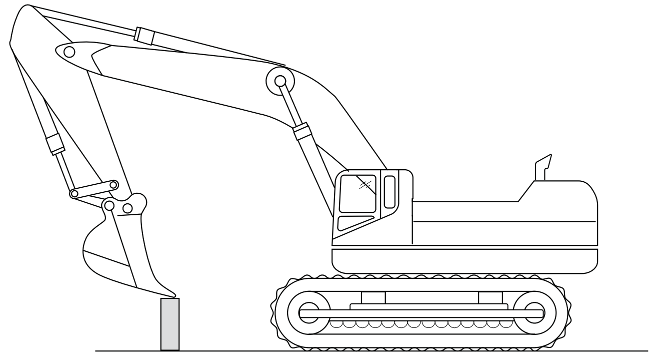


Bucket curled

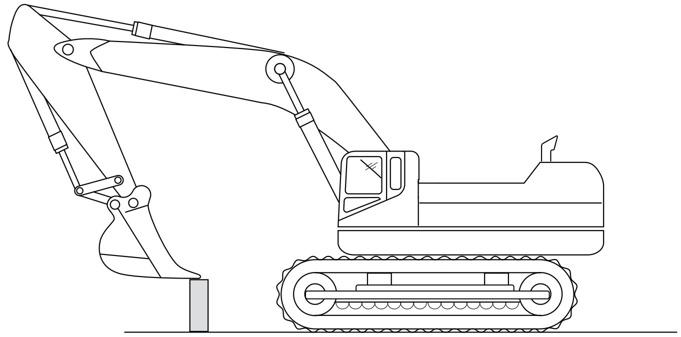


Record Bucket Positions with Boom and Stick Retracted

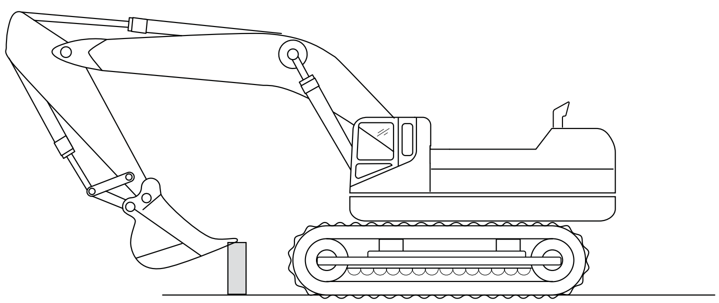
Bucket extended



Bucket mid-position



Bucket curled



If a hub with a known position is available, use those coordinates as the reference. Otherwise, use the first position as a reference. Compare each position to the reference. The difference should be within ± 0.2Ft.

Machine Elements Positional Accuracy

		N	E	Z	N Error	E Error	Z Error
Boom and bucket extended							
	Bucket extended				(reference)		
	Bucket mid-position						
	Bucket curled						
Boom and stick mid-position							
	Bucket extended						
	Bucket mid-position						
	Bucket curled						
Boom and stick retracted							
	Bucket extended						
	Bucket mid-position						
	Bucket curled						

If a hub with a known position is available, use those corrodinates as the reference.
Otherwise, use the first position as a reference.
Compare each position to the reference.
When comparing the measured positions with the reference position, the difference should be within ± 0.2Ft.

Testing Machine Body Sensor for Accuracy

Testing the sensor on the body requires comparing the hub position with the machine tilted at a cross slope (Figure 81).

1. Position the machine on a cross slope at approximately 5%.
2. Place the center of the bucket on a hub and record the position.
3. Rotate the machine 90 degrees, and place the center of the bucket on the same hub.
4. Record the new position, and then subtract the two positions from each other.
5. The difference between positions should be within +/- 0.2Ft.

		N	E	Z
Machine on Cross Slope				
	Position 1			
	Position 2			
Differences				

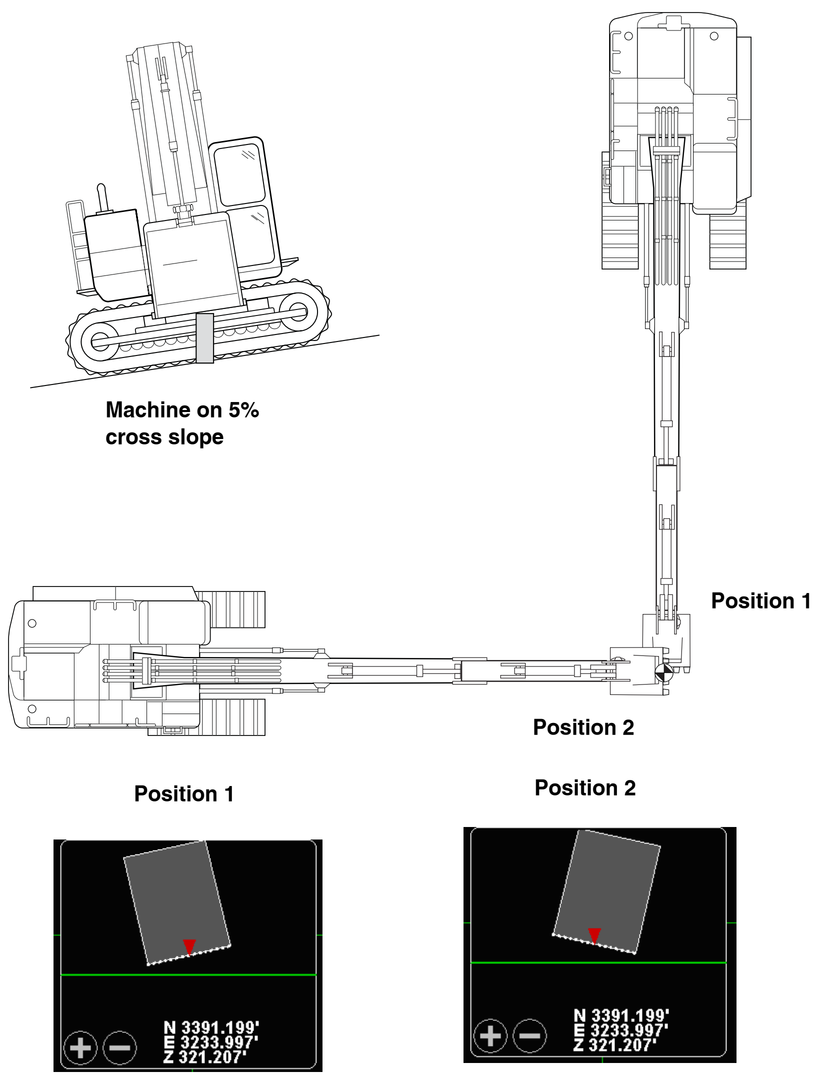


Figure 81: Check Cross Slope Accuracy

Topcon Positioning Systems, Inc.
7400 National Drive, Livermore, CA 94550
800·443·4567   www.topconpositioning.com

ISO 9001:2000
FM 68448

X-63/X-63i/X-62/X-33/X-32 Installation and Calibration Manual
P/N: 7010-0697   Rev E