Maintenance & Troubleshooting

Good daily care, preventive maintenance, and routine maintenance will prevent many problems before they occur.

Daily Care

The following guidelines provide for trouble-free operation:

- Keep all carrying cases clean and dry. Do not leave it open and exposed to the elements. Clean and dry all components prior to placing them into the carrying case.
- Ensure that protective connector caps, provided on some components, are in place when not using the cables. Water accumulating on the connectors can cause electrical shorts.
- Do not use high-pressure spray, water, or steam cleaner hoses directly on cables and components. The components can be used in the rain or light spraying.
- Check for loose components due to physical damage.
- Use proper battery supplies for components isolated from the machine (such as the Base Station). Keep the machine's battery in good condition.

Preventive Maintenance

Preventive maintenance will help to keep your 3Dxi components running smoothly and efficiently.

Touch Screen Display Cleaning

The Touch Screen Display should be cleaned often in order to maintain a quality image and prevent faulty operation.

Keep the front surface of the touch screen free of dirt, dust, fingerprints, and other materials that could degrade optical properties.

Long term contact with abrasive materials will scratch the front surface, and image quality will be detrimentally affected. For best results, use a clean, damp, non-abrasive cloth towel and any commercially available window cleaner to regularly clean the surface. Apply the cleaning solution to the towel rather than the surface of the touch screen. Many touch screens have air vents and are not designed with water tight bezels. Fluid ingress may occur from behind the panel if it is not cleaned properly.

1. Dust the display lightly with a non-abrasive cloth towel.
2. Dampen the towel with water or a very diluted mild/neutral detergent solution.

Never use alcohol, ether, benzene, acetone or any sort of solvent. Do not use a high-pressure spray. Do not spray towards the screen.

3. Wipe residual dust off with the damp towel.
4. Clean any residual detergent solution off by using a cloth dampened with only water. Then wipe water and damp area completely dry around the screen.

Lubricating Quick Removal Knobs

Periodically lubricate the quick removal knobs to prevent galling caused by tightening too strongly or through repetitive use (Figure 6-1).

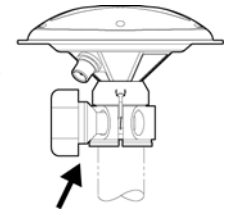


Figure 6-1. Lubricate Knobs (MC-A1 Example)

Simply apply a lubricant, such as normal grease, to the threads of the knob attachment.

Troubleshooting 3Dxi Components

In general, as long as you follow the maintenance and safety instructions provided in this manual, you should have few problems with your 3Dxi™. This section will help you diagnose and solve some common problems you may encounter with the various components.

Before contacting TPS customer support about any problems, try the following and see the following sections:

- Check that the various components (radio, MC-2.5 Box, GX-60 control box, Base Station, etc.) have power and are powered up.
- Check that all cables are securely and properly connected to the various components of the 3Dxi (GX-60 control box, antenna, etc.). See"Jobsite Setup" on page 4-1 for details.
- Disconnect cables and inspect them for damage or contamination. Clean all connections with an electrical contact cleaner.

Do not attempt to repair equipment yourself. Doing so will void your warranty and may damage the hardware.

Base Station

This section lists possible Base Station problems you may encounter (also refer to the Base Station's documentation). If you still have problems after trying the solutions listed here, contact TPS customer support.

Problem	
The GPS receiver does not power on.	
Causes	Solutions
The PWR button was pressed too quickly.	Make sure you hold the PWR button down for at least one second. A quick press will not activate the receiver.

The power cable is incorrectly connected or damaged.	Check that the power cable is correctly connected to the battery—RED to positive and BLACK to negative—and that the battery is charged. Check that the RED dots on the power cable connector and receiver power socket are aligned, and the cable is pushed in. If the power cable is damaged, contact your dealer to replace it.
Problem	
Radio modem does not power on.	
Causes	Solutions
The power cable is incorrectly connected or damaged.	Check that the power cable is correctly connected to the battery—RED to positive and BLACK to negative—and that the battery is charged. If the power cable is damaged, contact your dealer to replace it.
The radio receives power through the Legacy-E+ receiver.	Some radios do not require a separate power supply, but are supplied power through the port on the receiver. For these radios, check that the receiver is on.
Problem	
Pocket-3D does not connect to the GPS receiver.	
Causes	Solutions
The GPS receiver is off.	Check that the GPS receiver is on.
If using a cable, the cable may be incorrectly connected.	Check that the cable is connected to the COM port on the Pocket-3D controller and to Port A on the GPS receiver. Check that the correct receiver is selected in Pocket-3D. If still no connection, reset the controller and repeat the connection.

Problem	
Pocket-3D is waiting for satellites.	
Causes	Solutions
The cable is incorrectly connected or damaged.	Check that the antenna cable is not cross-threaded and is screwed in all the way. If the cable is damaged, contact your dealer to purchase a new cable.
The antenna has poor PDOP.	Check that the antenna has a clear view of the sky.
The receiver is collecting an almanac.	If this is the first time connecting to the GPS receiver, or if an internal reset has recently been performed, this message may persist for several minutes while the GPS receiver obtains a new almanac.
Problem	
Radio modem light is not flashing.	
Causes	Solutions
The cable is incorrectly connected or damaged.	Check that the cable from the receiver is properly connected to the radio. If the cable is damaged, contact your dealer to purchase a new cable.
The radio does not have a TX LED.	Some radios may not have a TX (Transmit) LED so the radio may in fact be functioning.
The radio has a TX LED, but it is not yet flashing.	All radio types specifically listed for the Base Station kit have a TX light and should flash every second. It may take several seconds after connection for this flashing to commence.

MC-2.5 Receiver Box

This section lists possible MC-2.5 Receiver Box problems you may encounter. If you still have problems after trying the solutions listed here, contact TPS customer support.

Problem	
All LEDs off.	
Causes	Solutions
The power cable may be incorrectly connected.	Power is supplied through the cable connected to Serial Port A. Check that the cable is properly connected
The MC-2.5 Receiver Box does not have power.	Power to the MC-2.5 Receiver Box depends on where power is connected to the machine. • If the MC-2.5 power is connected to the GX-60, turn on the control box. • If the MC-2.5 power is connected to the ignition, turn on the ignition.
Problem	
Satellite Status indicator does not flash green.	
Causes	Solutions
The cable is incorrectly connected or damaged.	Check that the antenna cable is not cross-threaded at the antenna and is connected to the intermediate cable installed on the machine. Check the connection at the GPS Antenna port on the MC-2.5 Box. If the cable is damaged, contact your dealer to purchase a new cable.
The antenna has poor PDOP.	Check that the Machine Antenna has a clear view of the sky.

The receiver is collecting an almanac.	If this is the first time connecting to the MC-2.5 Box, the LED may not flash for several minutes while the GPS receiver obtains a new almanac.
Problem	
Radio Status indicator does not flash green.	
Causes	Solutions
The Base Station and/or Base Station radio has a problem.	Check that the Base Station is running correctly and the TX light on the radio modem flashes on.
Different channels are used between the Base Station and the machine.	Check that the Base Station and Machine use the same radio channel. • For the Base Station, use the button on the radio modem or use the "GPS Radio Configuration" program with the Pocket-3D connected. See "Equipment Setup: Base Station" on page 4-1. • For the machine, use the GX-60 control box function. See "Changing Radio Channels" on page 5-27.
The antenna at the Rover or Base may be too low, incorrectly placed, or too far away.	If the green LED flashes when near the Base Station, but not when farther away, check that the machine's radio antenna mast is mounted vertically at the highest point on the machine. If the machine gets too far from the Base Station, elevate the radio antenna at the Base Station or move it to a closer Control Point.

GPS Localization

This section lists possible GPS localization problems you may encounter.

Problem	
Measurement takes too long.	
Causes	Solutions
The machine may be blocking satellite signals to the range-pole or tripod-mounted antenna.	Watch the status of the measurement screen. If the status indicates “waiting for satellites” move the machine away from the antenna.
The Control Point may be located too close to obstructions.	Move to an alternative Control Point or have the surveyor place a new Control Point away form the obstructions.
The MC-2.5 Box has not yet initialized; the system may be tracking many satellites.	The MC-2.5 Box may take several minutes to initialize.
The range-pole was unsteady.	Make sure that the pole is held steady while measurement is taking place. Any movement will make for a lengthy initialization and/or measurement.
Problem	
Localization produces large errors.	
Causes	Solutions
A typographical error occurred.	If errors are 10s or 100s of feet or meters, it is likely that a typographical error has occurred. If coordinates are manually entered, check that longitudes are correctly prefixed with a minus sign if working in the western hemisphere (for example, USA). Re-enter the coordinates.

The range-pole was unsteady.	If the errors are decimeter level in magnitude, it may point to either inaccurately measured local site coordinates or not holding the range-pole vertical when measuring the GPS coordinates.
Inaccurate local site coordinates or erroneous GPS measurement.	If error values of the first few points are reasonable but increase when a new point is measured, the point just measured must have either inaccurate local site coordinates or erroneous GPS measurement. To isolate the error, disable horizontal and/or vertical localization for each Control Point in turn and observe the set of errors. When the errors become acceptable due to certain isolation, the point isolated is most likely to detract from the quality of the localization. Also, as a general rule, if error values of the first few points are reasonable but increase when a new point is measured, the point just measured must have either inaccurate local site coordinates or erroneous GPS measurement. Once a problematic Control Point is discovered, try to re-measure the point again to see any improvement. If it is still suspect and affects the acceptable tolerance, the horizontal and/or vertical localization for this point may be disabled.

Problem	
There are no H.Error and V.Error values.	
Causes	Solutions
"Use for horizontal GPS localization" and/ or "Use for vertical GPS localization" check boxes may not have been selected.	These check boxes need to be selected for a minimum of three points. Note that the error value will be calculated once three Control Points are measured and used for the GPS localization. This troubleshooting is useful when the Pocket-3D is being used to perform GPS localization as well as the GX-60 control box.

GX-60 Control Box

This section lists possible GX-60 control box problems you may encounter.

Problem	
The control box does not power on.	
Causes	Solutions
The cable is the wrong cable, incorrectly connected, or damaged.	Check that the power cable supplies 12 to 24 VDC. • A and B sockets = power • C and D sockets = ground Check that the power cable is connected to the correct port (see "GX-60 Control Box Features" on page 2-1) and the ends are securely fastened. If the cable is damaged, contact your dealer to purchase a new cable.

Problem	
Screen has transferred to operating system.	
Causes	Solutions
"Exit 3DMC" function may have been pressed unexpectedly or incorrectly.	Look for the "3DMC" icon and double-tap on it. The application program will open and return to the Main Screen.
Problem	
"Control file has no GPS localization" message.	
Causes	Solutions
Not enough Control Points used for localization.	Press **Ok** to exit the message screen. Check that the Control Points file used has a minimum of three localized points. Perform the localization process again.
No GPS localization has been performed for the project.	Plan to implement the GPS localization. See "GPS Localization" on page 4-19 for detailed instructions.
Problem	
"Loading…." or "Building…." message.	
Causes	Solutions
3DMC is in the middle of loading files or making graphics.	If the pointer on the Main Screen moves when you tap in different places, 3DMC is computing. When the system is busy, the pointer becomes an hourglass. Wait for a few more minutes to let it complete the process. Remember, computing will take longer when a larger file is selected.

If the pointer does not move, the control box may have a computing problem.	Switching off the control box can fix the computing problem.
Problem	
Elevation Control key displays: “GPS receiver not connected!”	
Causes	Solutions
Either the GPS signal or radio signal is invalid. The graphic may indicate what causes the problem.	For GPS signal, check cable connections along the GPS antenna cable from the GPS Antenna port on the MC-2.5 Box to the Machine Antenna. Check connections at the System Five-3D port on the MC-2.5 Box and Connector A on the control box.
Problem	
Elevation Control key displays: “Waiting for radio link”.	
Causes	Solutions
Radio transmission, radio antenna, lights status on the GPS receiver, and/or power may have a problem.	Check that the Base Station is working correctly. See “Base Station” on page 6-4 to troubleshoot Base Station problems. Also check that the Machine Radio Antenna on the machine and its cable connections are properly connected. Make sure that the radio channel is identical between the Base Station and the Machine, and that the radio is correctly configured on the Control Computer. For more information, see “Equipment Setup: Base Station” on page 4-1 and “Machine Setup” on page 4-9.

Problem	
Elevation Control key displays: “Waiting for Initialization”.	
Causes	Solutions
The GPS receiver has not been successful tracking enough valid satellites.	Check that the Machine Antenna has a clear view of the sky. Check for obstructions, such as trees, buildings, and vehicles, that can block or reflect satellite signals.
The system is still in the process of determining a solid position.	If this is the very first time for operation, this message may persist for several minutes while the Legacy-E+ obtains a new almanac.
Problem	
Elevation Control key displays: “Out of design area”.	
Causes	Solutions
The machine is out of the Design Surface area.	Make sure that the correct Control Point File and Design Surface file is selected. Move into the Design Surface area so the operator can start grading.
Problem	
Elevation Control key displays: “No GPS localization”.	
Causes	Solutions
The Control Points file currently selected has not been localized properly.	Make sure that the correct Control Points file currently is selected.
You are in a process of building a Control Point file or just starting the process.	Disregard the message until the localization is complete. See “GPS Localization” on page 4-19 to perform localization.

Problem	
Elevation Control key displays: “Slope Sensor Offline”.	
Causes	Solutions
A TS-1 has become disconnected (unplugged).	Check all cable connections going to the various TS-1 sensors on the body, boom, stick, dog-bone (optional), quick coupler (optional), and bucket (optional if using a quick coupler).

Notes:

TS-1 Calibration

The TS-1 sensors provide lateral and longitudinal angle measurements, regardless of the object's position in space. The sensors accurately measure the position of the body, boom, stick and bucket, sending this angle data to the GX-60 control box to provide precise grade and slope. Each sensor is configured and calibrated for its specific location on the excavator.

Refer to the *3Dxi Installation and Calibration Manual* for specific details. The following sections are the chapter three from this manual.

Before calibrating TS-1 sensors, note the following:

When the system if first powered on, it may take several minutes for the GX-60 to discover (detect) each sensor.

Check sensor 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.

Also, serial numbers ending with 00 or 01 may cause communication conflicts.

Unless otherwise noted, each step of the calibration process must be performed individually and in order. That is, steps should not be combined or performed out of order.

Performing sensor calibrations as described in this chapter will prevent communication problems.

Measuring Machine Lengths

As accurately as possible, enter the machine dimensions into the 3DMC machine builder (Table A-1). Verification and adjustment for several critical lengths are described the *3Dxi Installation and Calibration Manual*.

NOTICE

Incorrect measurements or data entry errors have a direct affect on grading accuracy.

Take each measurement twice to ensure accuracy.

Table A-1. Machine Measurements

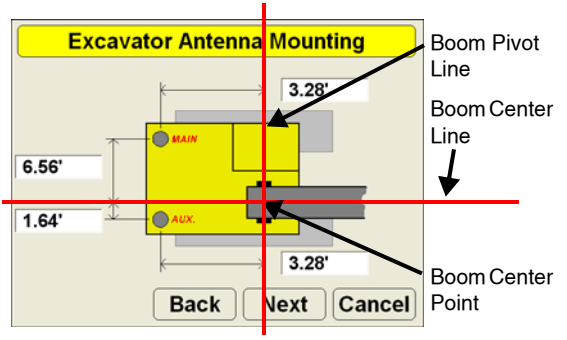
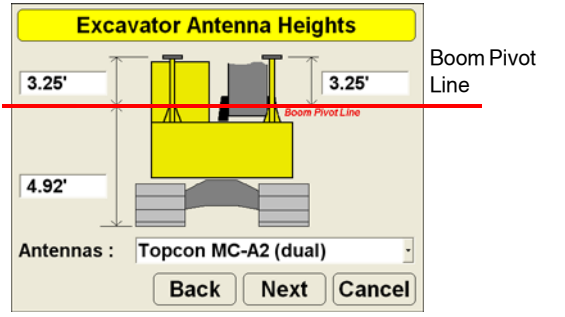
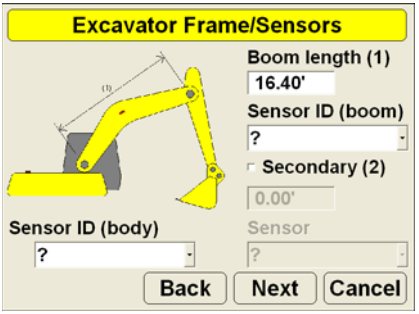
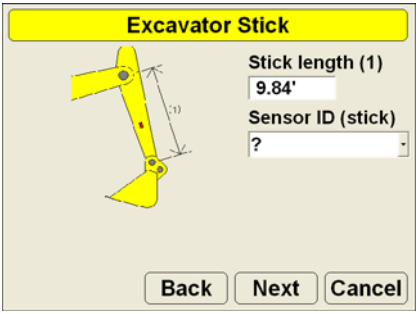
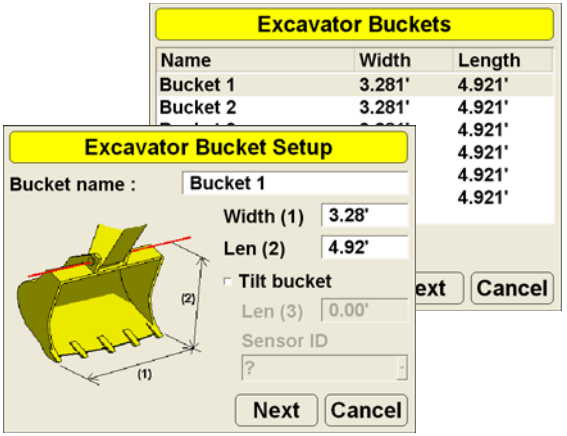
Measurements To Take	Screen Shot
Antenna Positions	
Antenna Heights	

Table A-1. Machine Measurements (Continued)

Measurements To Take	Screen Shot
Boom Length	
Stick Length	
Bucket Width and Length (repeated for each bucket)	

Entering Sensor Information

Before calibrating the sensors on a 3Dxi system, set up each sensor in 3DMC. You will need the following information:

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

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

1. In 3DMC, tap Topcon Logo ▸ Control ▸ Machine setup.
2. Select a current machine file and press **Edit**, or press **New** to create a new machine file.

   Refer to the *3Dxi Reference Manual* for further information on creating a machine file.
3. Press **Next** to navigate to the Excavator Frame/Sensors screen.
4. Tap any Sensor ID box and select the factory ID of the sensor corresponding to the machine element. Tap the Wrench button.

   You may need to select a random ID, then view the serial number on the Sensor Calibration screen to determine the sensor's location. Return to the Excavator Frame/Sensors screen and select another sensor. Repeat until the correct sensor is selected.

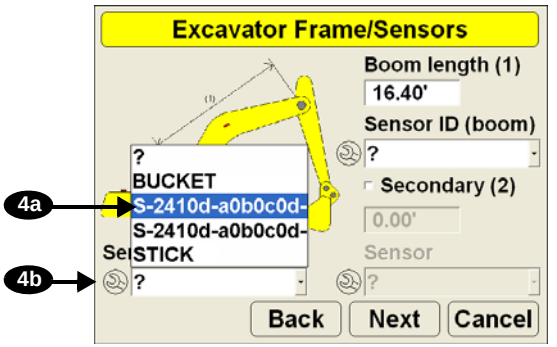


Figure A-1. Select Factory Sensor ID

5. Tap the Name box and enter a name the sensor according to its mounting location. Press **Ok**.

The sensor's serial number displays in the screen header.

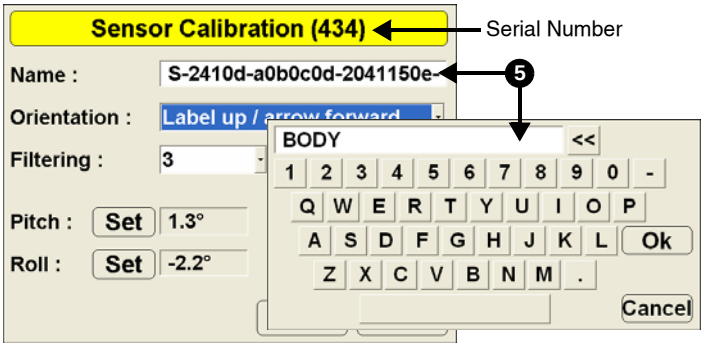


Figure A-2. Enter New Sensor Name

6. Repeat steps 4 and 5 for all remaining frame sensor(s).

You can select any wrench icon to change the name of a sensor. In the next step ("Step 2: Assign sensor IDs" on page A-6), you will assign a sensor to each machine component.

Step 2: Assign sensor IDs to each of the machine elements.

1. Navigate to the Excavator Frame/Sensor screen.
2. Tap the Sensor ID box and select the corresponding sensor for selected machine element.
3. Repeat step 3 for the remaining frame sensor(s).
4. Press **Next** and repeat step 3 for the stick sensor.
5. Press **Next** and repeat step 3 for the bucket sensor.

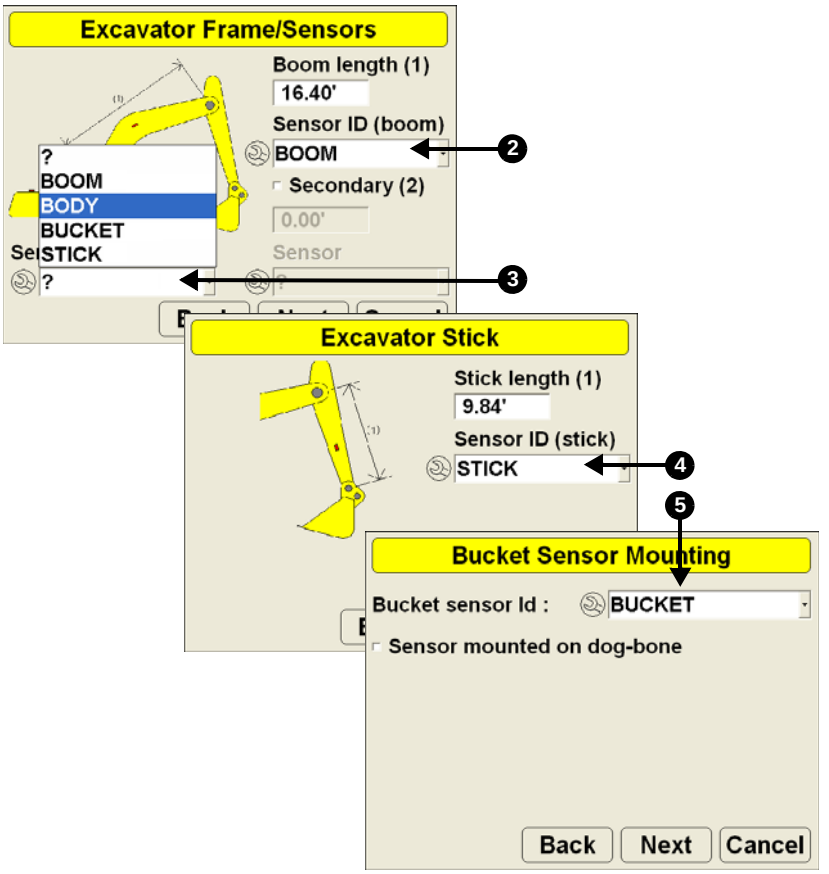


Figure A-3. Select Sensor For Machine Element

Step 3: Set sensor orientations for the machine elements.

1. Navigate to the Excavator Frame/Sensor screen.
2. Tap the Wrench button for the desired sensor.
3. Tap the Orientation box and select the physical orientation of the mounted sensor. Press **Ok**.

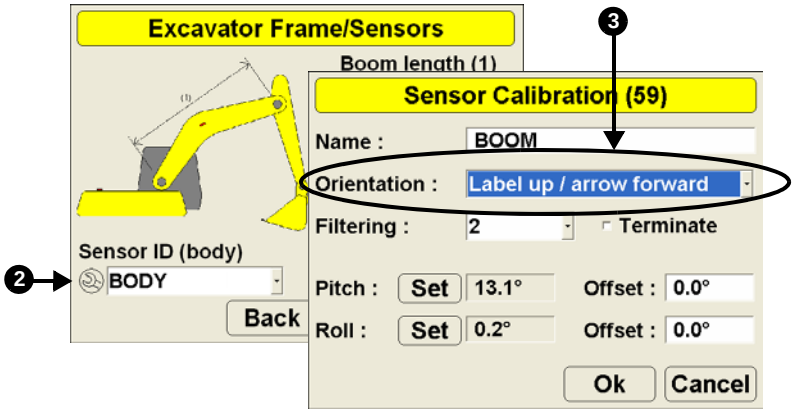


Figure A-4. Select Sensor Orientation

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

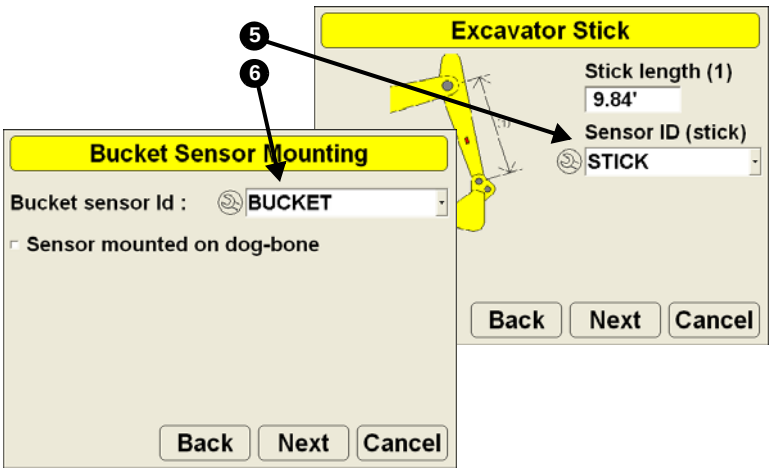


Figure A-5. Enter Sensor Orientation

Calibrating the Sensors

Once the sensors have been named, assigned to a machine element and the orientation selected, each sensor needs to be calibrated using 3DMC. A sensor calibration can be performed at any time.

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.

> **TIP** Perform the body sensor calibration on a slight slope to make it more obvious that the calibration was completed properly.

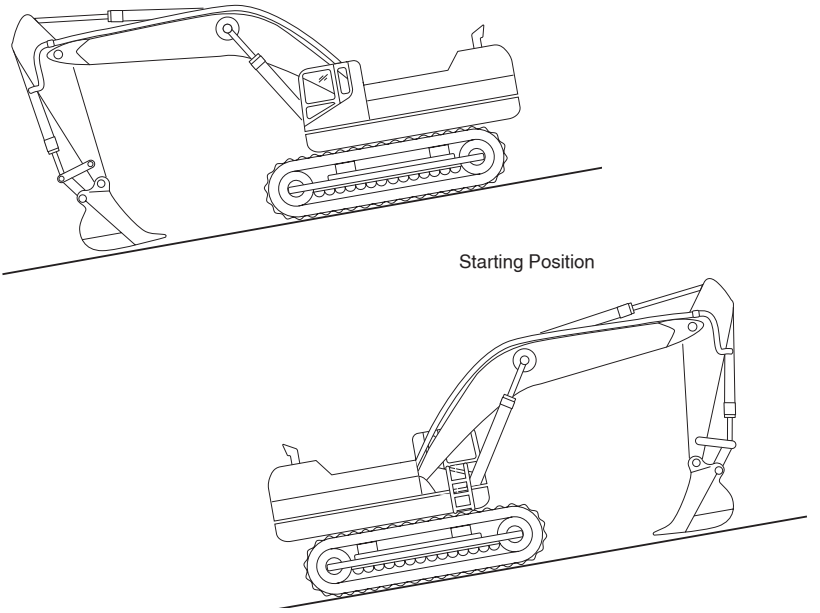


Figure A-6. Body Calibrations for Latitudinal Slope

1. Position the machine on a 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 3DMC, tap Topcon Logo ▸ Control ▸ Machine setup. Select the applicable machine file for the job and press **Edit**. Press **Next** to navigate to the Excavator Frame/Sensors screen.
5. Tap the Wrench button that corresponds to the body sensor.
6. Set both pitch and roll values to zero.

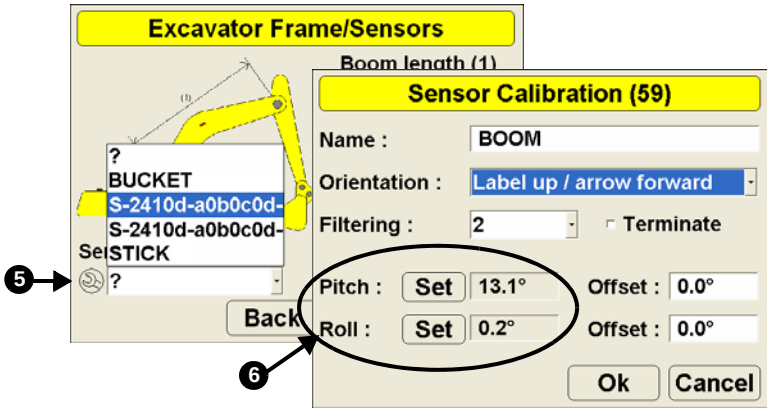


Figure A-7. Set Pitch and Roll Values to Zero

7. Without moving the tracks, rotate the machine 180° (position 2).
8. Set the pitch and roll to half the displayed values (for example, 13.1 / 2 = 6.55 and 0.2 / 2 = 0.1).

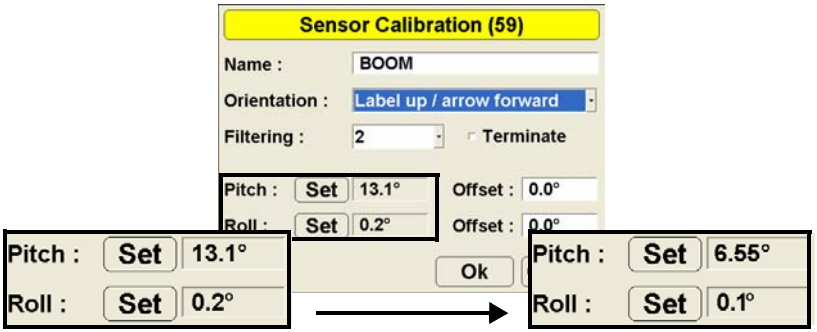


Figure A-8. Set New Pitch and Roll Value to Half

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.

Boom Sensor Calibration

The boom sensor calibration requires only the pitch calibration. When performing the boom sensor calibration, a total station or laser is required to correctly position the boom at zero degrees.

The installer may prefer to use a different instrument, such as a total station, for this step; however, for simplicity, the following steps illustrate a rotating laser.

1. Position the machine on a stable surface free of obstructions and rotate the body parallel to the tracks.
2. Place a zero slope rotating laser along the side of the machine to shine on both the boom pivot and stick pivot.
3. Adjust the laser height to strike the center of the boom pivot (Figure A-9).
4. Move the boom to align the stick pivot with the laser (Figure A-9).

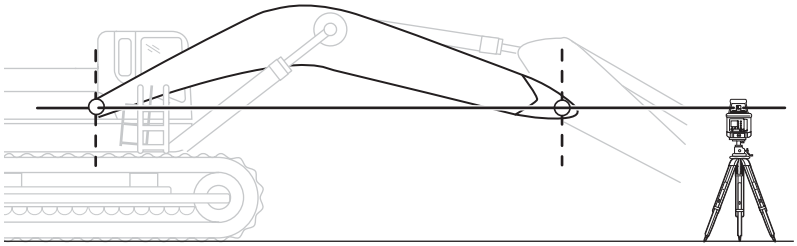


Figure A-9. Place Laser to Strike Center of Boom Pivot

5. In 3DMC, tap Topcon Logo ▸ Control ▸ Machine setup. Select the applicable machine file for the job and press **Edit**. Press **Next** to navigate to the Excavator Frame/Sensors screen.
6. Tap the Wrench button that corresponds to the boom sensor (Figure A-10 on page A-11).
7. Set the pitch to zero and press Ok (Figure A-10 on page A-11).

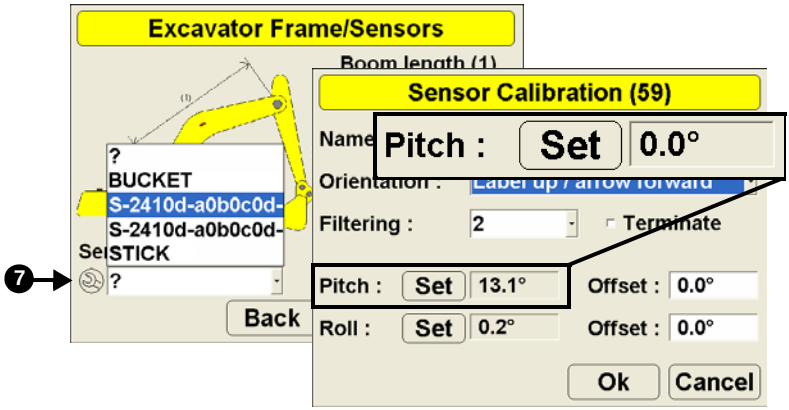


Figure A-10. Set Pitch Value to Zero

8. Navigate through the remaining steps of Machine setup, saving the file and exiting.
9. On the Main Screen of 3DMC, view a profile of the machine and verify that the boom is horizontal.

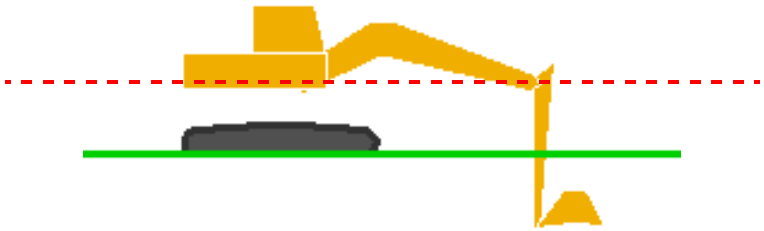


Figure A-11. Verify Position of Boom on Main Screen

Secondary Boom Sensor Calibration (Optional)

Like the primary boom sensor, the secondary boom sensor calibration requires only the pitch calibration. The same method used for calibrating the primary boom sensor is used to calibrate the secondary boom sensor. See “Boom Sensor Calibration” on page A-10 for details.

1. Position the machine on a stable surface free of obstructions and rotate the body parallel to the tracks.
2. Place a zero slope rotating laser along the side of the machine to shine on both the boom pivot and stick pivot.
3. Adjust the laser height to strike the center of the boom pivot.
4. Move the boom to align the stick pivot with the laser.
5. In 3DMC, tap Topcon Logo ▸ Control ▸ Machine setup. Select the applicable machine file for the job and press **Edit**. Press **Next** to navigate to the Excavator Frame/Sensors screen.
6. Tap the Wrench button that corresponds to the secondary boom sensor (Figure A-12).
7. Set the pitch to zero and press Ok (Figure A-12).

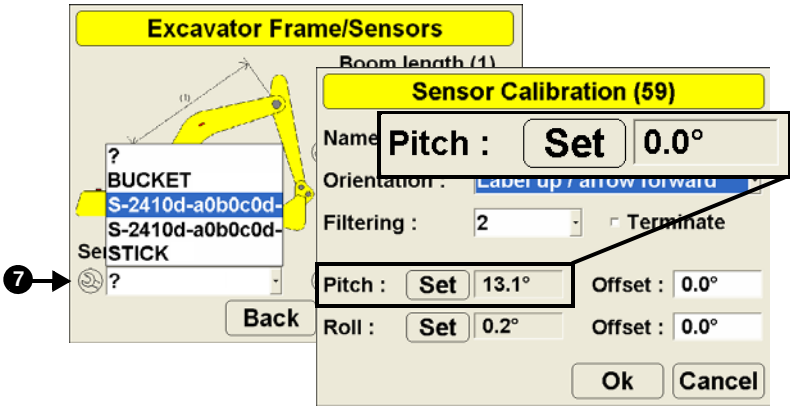


Figure A-12. Set Pitch Value to Zero

8. Navigate through the remaining steps of Machine setup, saving the file and exiting.

Stick Sensor Calibration

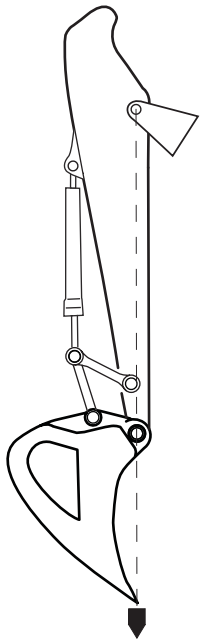
The stick sensor calibration requires only the pitch calibration. When performing the stick sensor calibration, a total station or plumb bob is required to correctly position the stick at zero degrees.

The installer may prefer to use a different instrument, such as a total station, for this step; however, for simplicity, the following steps illustrate a plumb bob.

The plumb setup for both stick and bucket sensor calibrations is the same. Perform both calibrations at the same time to save time.

Unless mounting a sensor to the dog-bone. In this case, perform stick/bucket calibrations separately.

1. Position the machine on a stable surface free of obstructions and rotate the body parallel to the tracks.
2. Attach a plumb bob to the boom-stick pivot.
3. Move the stick to align the bucket pivot with the plumb bob.
4. In 3DMC, tap Topcon Logo ▸ Control ▸ Machine setup. Select the applicable machine file for the job and press **Edit**. Press **Next** to navigate to the Excavator Stick screen.
5. Tap the Wrench button for the stick sensor (Figure A-13 on page A-14).
6. Set the pitch to -90.0 and press Ok (Figure A-13 on page A-14).



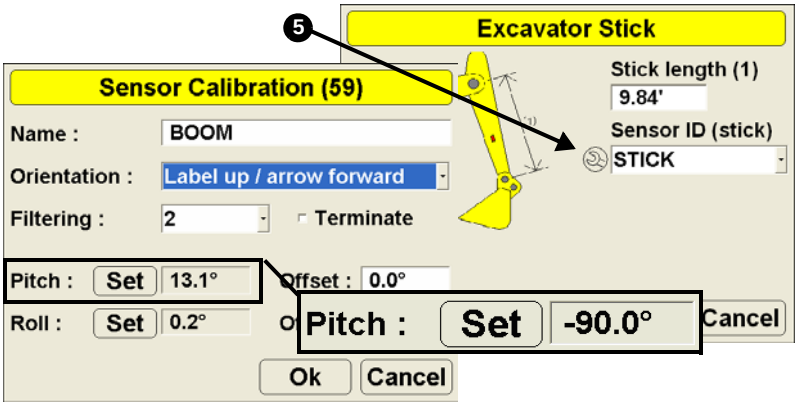


Figure A-13. Set Pitch Value to -90.0

7. Navigate through the remaining steps of Machine setup, saving the file and exiting.
8. On the Main Screen of 3DMC, view a profile of the machine and verify that the stick is vertical.

Figure A-14. Verify Position of Stick on Main Screen

Bucket Sensor Calibration

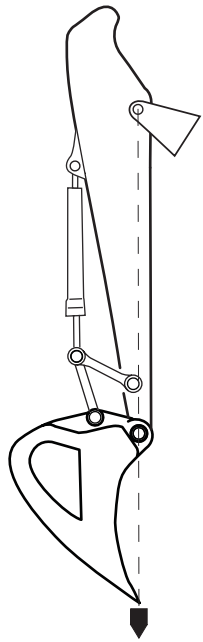
The bucket sensor calibration requires only the pitch calibration. When performing the bucket sensor calibration, a total station or plumb bob is required to correctly position the bucket at zero degrees.

The installer may prefer to use a different instrument, such as a total station, for this step; however, for simplicity, the following steps illustrate a plumb bob.

The plumb setup for both stick and bucket sensor calibrations is the same. Perform both calibrations at the same time to save time.

Unless mounting a sensor to the dog-bone. In this case, perform stick/bucket calibrations separately.

1. Position the machine on a stable surface free of obstructions and rotate the body parallel to the tracks.
2. Attach a plumb bob to the boom-stick pivot.
3. Move the bucket to align the bucket teeth with the plumb bob.
4. In 3DMC, tap Topcon Logo ▸ Control ▸ Machine setup. Select the applicable machine file for the job and press **Edit**. Press **Next** to navigate to the Bucket Sensor Mounting screen.
5. Tap the Wrench button for the bucket sensor (Figure A-15 on page A-16).
6. Set the pitch to -90.0 and press Ok (Figure A-15 on page A-16).



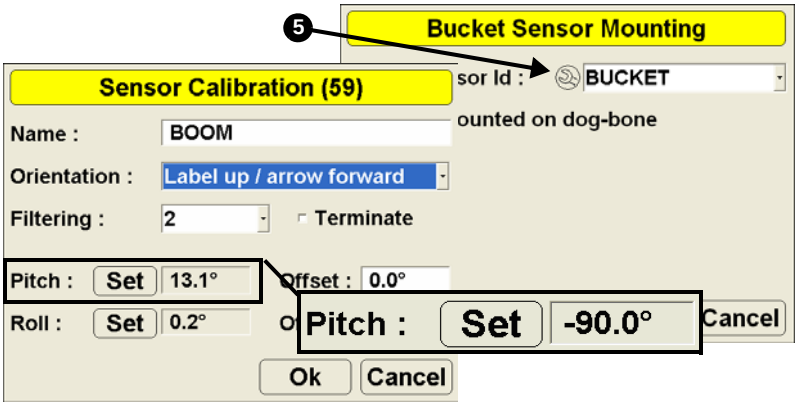


Figure A-15. Set Pitch Value to -90.0

7. Navigate through the remaining steps of Machine setup, saving the file and exiting.
8. On the Main Screen of 3DMC, view a profile of the machine and verify that the bucket is vertical.

Figure A-16. Verify Position of Bucket on Main Screen

9. If this is the last sensor physically connected to the machine, see “CAN Termination” on page A-24.

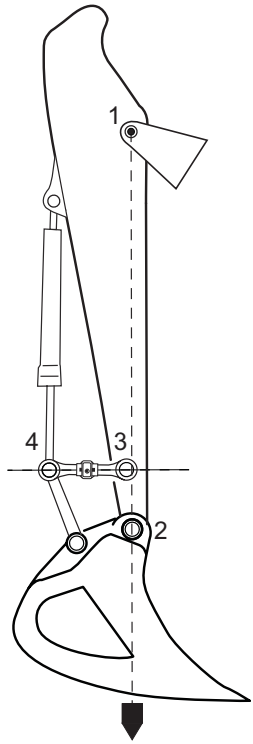
Dog-bone Sensor Calibration

The dog-bone sensor calibration requires only the pitch calibration. When performing the dog-bone sensor calibration, a total station or plumb bob is required to correctly position the dog-bone at zero degrees.

The installer may prefer to use a different instrument, such as a total station, for this step; however, for simplicity, the following steps illustrate a plumb bob.

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. Attach a plumb bob to the boom-stick pivot.
3. Move the stick to align the bucket pivot with the plumb bob.
4. Move the bucket so the dog-bone is horizontal (points 3 and 4 in the figure at right).
5. In 3DMC, tap Topcon Logo ▸ Control ▸ Machine setup. Select the applicable machine file for the job and press **Edit**. Press **Next** to navigate to the Bucket Sensor Mounting screen.
6. Tap the Wrench button for the bucket sensor (Figure A-17 on page A-18).



7. Set the pitch to zero and press Ok (Figure A-17).

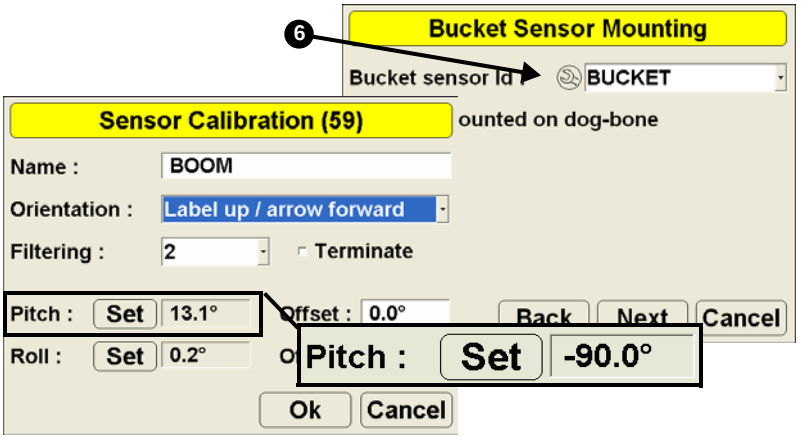


Figure A-17. Set Pitch Value to Zero

8. On the Bucket Sensor Mounting screen, check that "Sensor mounted on dog-bone" is selected and tap Next.
9. Measure and enter the four lengths of the dog-bone joint, then press Calibrate (Figure A-18).

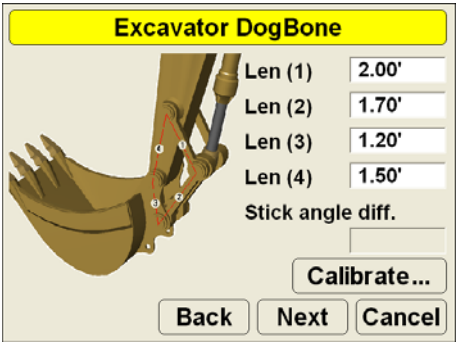
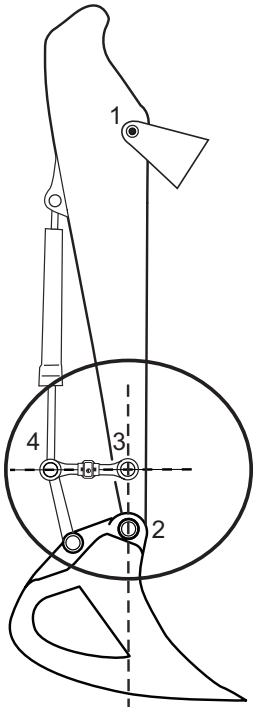


Figure A-18. Determine Stick Angle Difference

10. Move the stick approximately vertical. Position the total station directly to the side of the stick to reduce parallax error.

11. Align points 2, 3, 4 with the cross hair of the total station as follows:
    - Move the stick to align points 2 and 3 with the vertical cross hair.
    - Adjust the total station to place the horizontal cross hair on point 3.
    - Move the bucket so point 4 is also on the horizontal cross hair.

    All three points should be aligned on the cross hairs as shown in figure at right.



12. Enter 90 for Angle (1) and press Ok (Figure A-19).

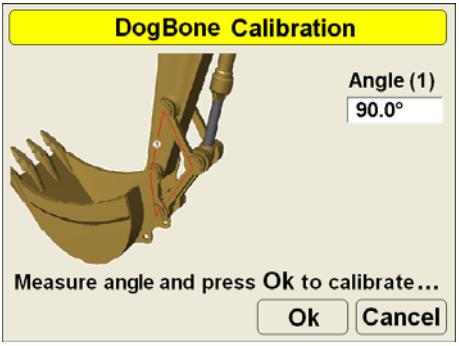
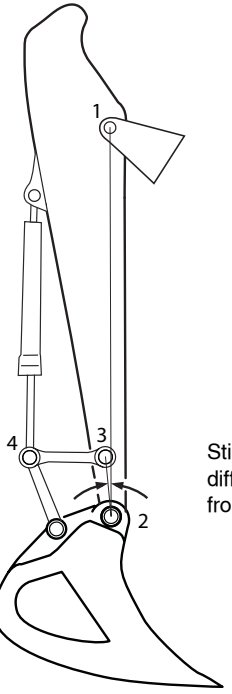
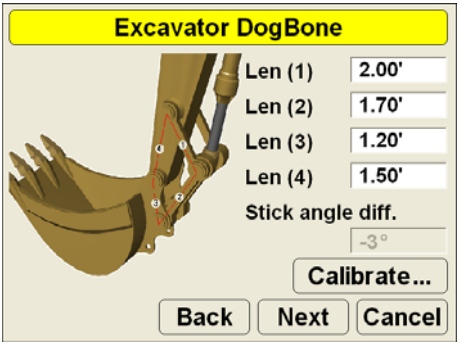


Figure A-19. Determine Stick Angle Difference

The *Stick angle difference* box will display the angle of points 1-2-3 and should be less than 10 degrees (Figure A-20). This will vary by machine geometry.





Stick angle difference calculated from points 1-2-3

Figure A-20. Verify Position of Bucket on Main Screen

After completing the dog-bone calibration, calibrate the bucket to vertical as seen in “Multiple Bucket Calibration” on page A-21.

13. Navigate through the remaining steps of Machine setup, saving the file and exiting.
14. After completing the dog-bone calibration, calibrate the bucket to vertical as seen in “Multiple Bucket Calibration” on page A-21.
15. If this is the last sensor physically connected to the machine, see “CAN Termination” on page A-24.

Multiple Bucket Calibration

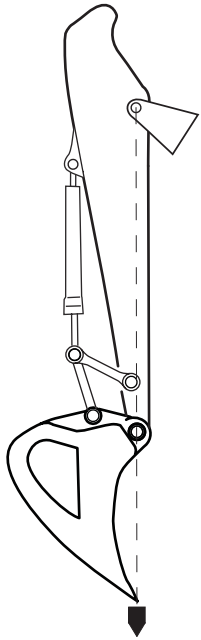
If a using a quick change coupler to switch buckets, the geometry difference between buckets must be determined. Once loaded into 3DMC, the bucket can be quickly selected on the fly. When calibrating multiple buckets, only the bucket's measurements will differ for standard buckets.

Only the geometry difference between buckets will need to be calculated. The calibration process as seen in "Bucket Sensor Calibration" on page A-15 will remain the same for the sensor.

When performing the bucket sensor calibration, a total station or plumb bob is required to correctly position the bucket at zero degrees.

The installer may prefer to use a different instrument, such as a total station, for this step; however, for simplicity, the following steps illustrate a plumb bob.

1. Position the machine on a stable surface free of obstructions and rotate the body parallel to the tracks.
2. Attach a plumb bob to the boom-stick pivot.
3. Move the bucket to align the bucket teeth with the plumb bob.
4. In 3DMC, tap Topcon Logo ▸ Control ▸ Machine setup. Select the applicable machine file for the job and press **Edit**. Press **Next** to navigate to the Excavator Buckets screen.
5. Press Edit and enter the bucket width and length; change the name if desired. Press Next (Figure A-21 on page A-22).



If setting up a tilt bucket, select the option. Enter the distance from the bucket to the tilt joint. Tap the Wrench button and enter sensor information as described in “Entering Sensor Information” on page A-4. Then press Next.

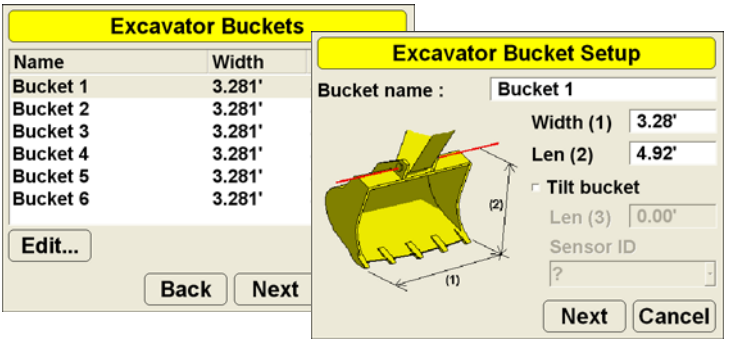


Figure A-21. Edit Bucket Measurements

6. With the bucket plumb, press Calibrate. Press Ok at the confirmation. When done, press Next.

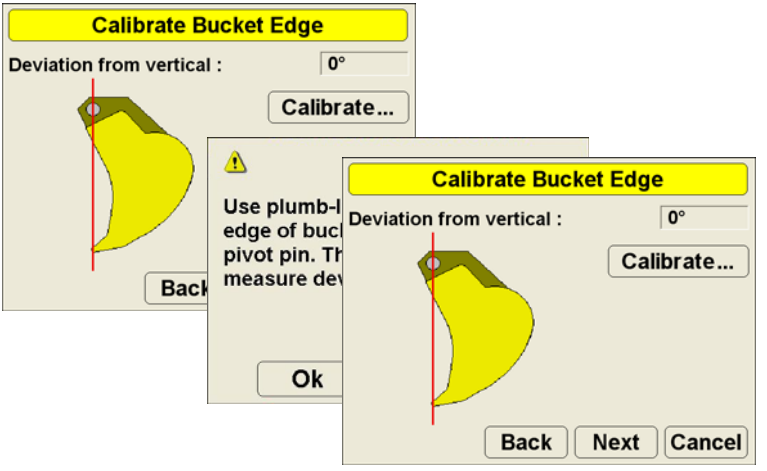


Figure A-22. Calibrate Bucket Edge

7. Move the bucket horizontally, checking that the pivot and base are level. Press Calibrate then Ok at the confirmation. When done, press Finish.

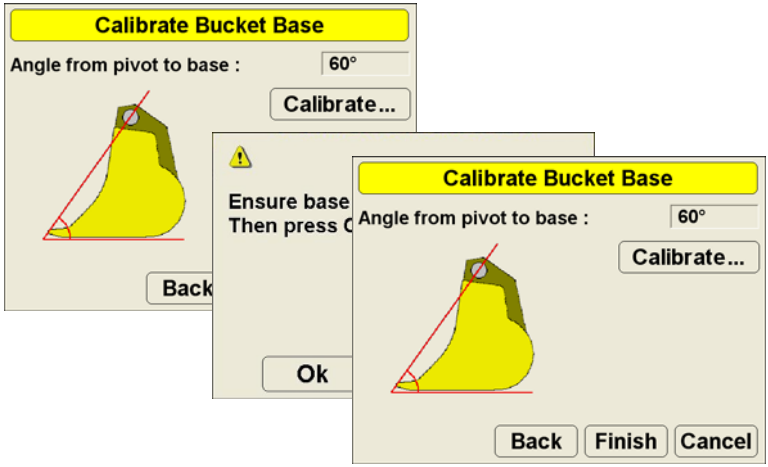


Figure A-23. Calibrate Bucket Base

8. On the Main Screen of 3DMC, view a profile of the machine and verify that the bottom of the bucket is flat on the ground.

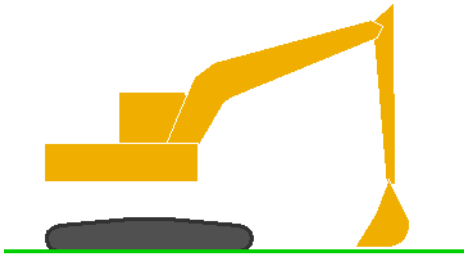


Figure A-24. Verify Position of Bucket on Main Screen

9. Repeat these steps for all desired buckets. After saving the machine file, use the Topcon Logo ▸ Control ▸ Bucket menu to change the bucket used in 3DMC.

CAN Termination

To ensure proper communication between the sensors and the GX-60, the last sensor physically connected must have CAN termination. Typically, this will be the bucket sensor (or the tilt bucket sensor).

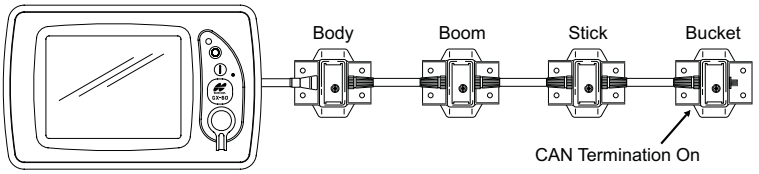


Figure A-25. Sensor Furthest from GX-60 gets CAN Termination

1. In 3DMC, tap Topcon Logo ▸ Control ▸ Machine setup. Select the applicable machine file and press **Edit**. Press **Next** to navigate to the (bucket) sensor screen.
2. Tap the Wrench button for the sensor furthest from the GX-60 (Figure A-26).
3. Select and turn on Terminate (Figure A-26).

Do not select this option for more than one sensor. Only select this option for the last sensor.

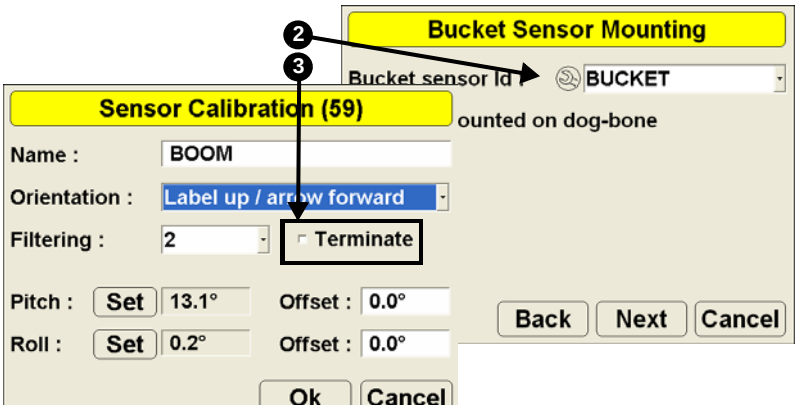


Figure A-26. Set CAN Termination for Last Sensor (Bucket Sensor)

4. Navigate through the remaining steps of Machine setup, saving the file and exiting.

Sensor Filtering

The filter level for each sensor can be changed depending on the application and operator's choice. A value of 4 (Heavy) will dampen sensor reaction, while a value of 1 (Light) will cause faster sensor reaction. The default filter level is 2.

1. In 3DMC, tap Topcon Logo ▸ Control ▸ Machine setup. Select the applicable machine file and press **Edit**. Press **Next** to navigate to the desired machine element sensor screen.
2. Tap the Wrench button for the desired sensor GX-60 (Figure A-27).
3. Select a filtering level and press Ok (Figure A-27).
4. Navigate through the remaining steps of Machine setup, saving the file and exiting.

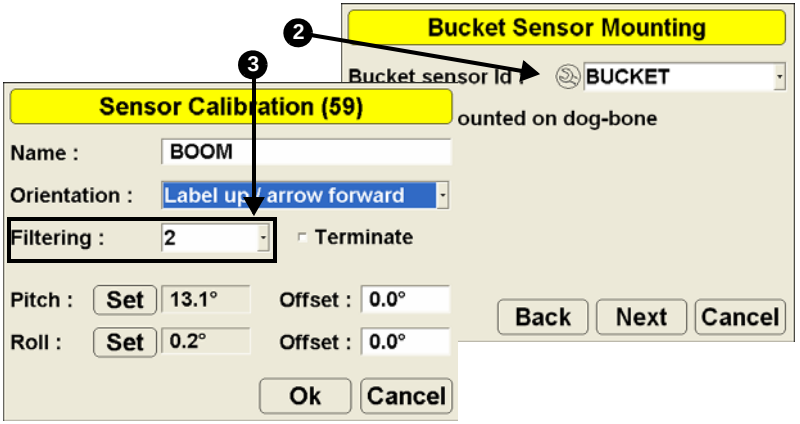


Figure A-27. Set Filtering Level (Bucket Sensor)

Notes:

Pocket-3D Getting Started Guide

Pocket-3D is grade and staking control software for hand-held controllers. At the jobsite, Pocket-3D provides a way to make quick changes and updates to files, double-check control points, initialize the GPS base, and many other useful functions.

3DMC and Pocket-3D save files in the same format, making it simple to share files and updates between surveyors, machine operators, grade checkers, etc.

Refer to the *Pocket-3D User's Manual* and *Pocket-3D Reference Manual* for further details.

Before performing any Pocket-3D configuration or application function, check the units used at the job. Units are the method of measurement used for measuring various data. To check, change, or apply units to the project, tap **Setup** ▸ **Units** (Figure B-1).

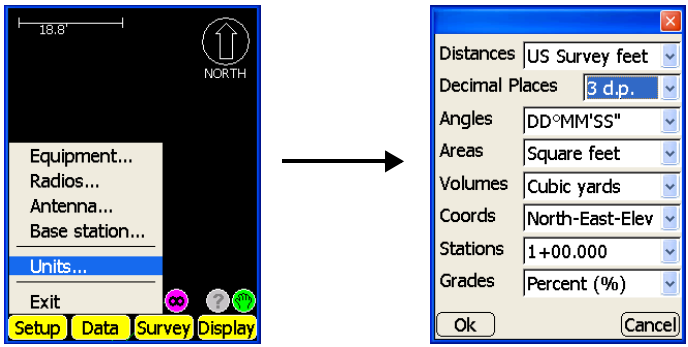


Figure B-1. Setup Units

Equipment Setup: GPS

Equipment setup consists of jobsite files to ensure correct data is used for positioning activities and a machine file to ensure the correct measurements are taken.

Step 1: Create a Control Point File

First, create a control point file (Figure B-2):

1. Tap **Data** ▸ **Control** ▸ **[<none> or file name]**.
2. Tap **New** to create a control point file.
3. Enter a name for the file and press **Ok**.
4. Select the control point file and press **Ok**.
5. Press **Yes** to apply the file to the jobsite.

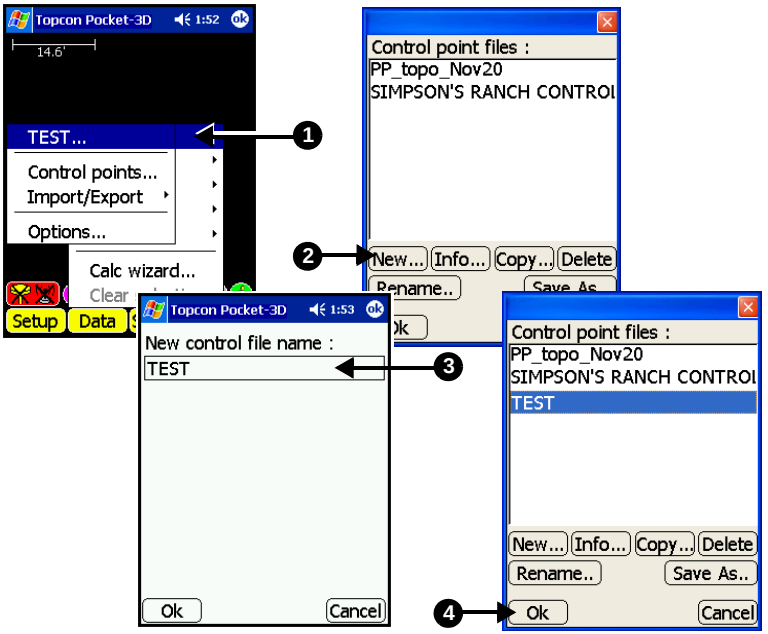


Figure B-2. Create a Control Point File

Then, enter control point data into the file (Figure B-3):

1. Tap **Data** ▸ **Control** ▸ **Control points**.
2. Tap **Add** to enter the local coordinates for the control point.
3. Enter a name and description for the control point and its local coordinates. Press **Ok**.
4. Repeat steps 2 and 3 for each control point.
5. Press **Ok** to save the data.

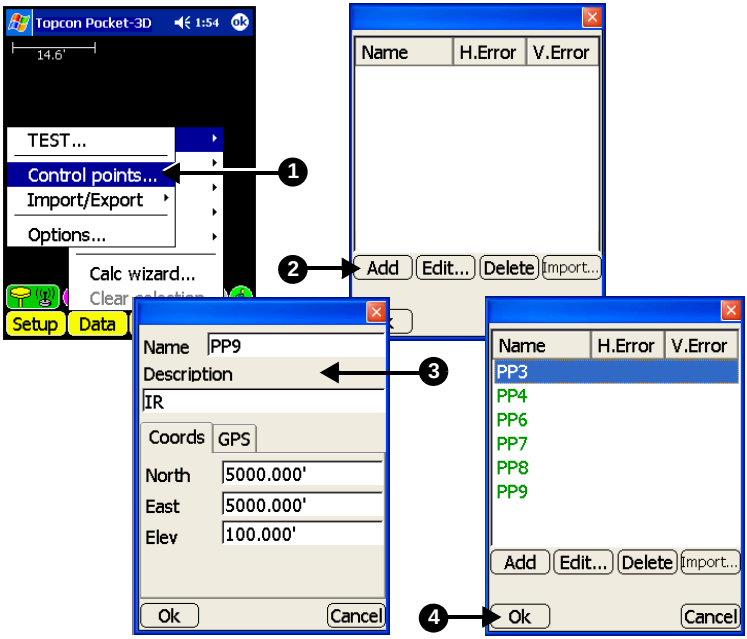


Figure B-3. Enter Control Points

Step 2: Setup and Initialize a Base Station

For a GPS Base Station, enter antenna and radio information (Figure B-4):

1. Connect the controller and receiver. Tap **Setup ▸ Base station**.
2. Select the control point over which the base station is installed and the connection between controller and receiver. Press **Next**.
3. Enter antenna type and height information. Press **Next**.
4. Enter radio type and communication information. If using a Pacific Crest PDL UHF radio, press **Configure** to select channel information and press **Set**. Press **Next**.
5. Select GPS receiver settings. Press **Finish** to initialize the GPS receiver and start the Base.
6. Immediately disconnect the Pocket-3D controller from the receiver. Performing any other activities while connected will convert the Base to a Rover.

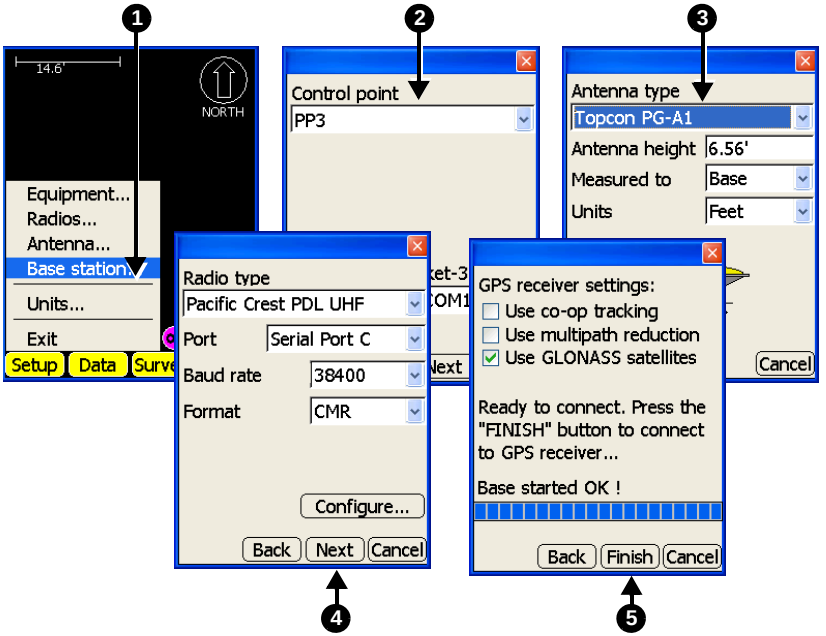


Figure B-4. Enter Base Station Information and Start Base

Step 3: Create a Range Pole Equipment Configuration

Pocket-3D creates an equipment configuration for a range-pole Rover (Figure B-5 to Figure B-7). A Rover can be used to check and verify grade.

1. After initializing the Base, connect the Pocket-3D controller to the Rover GPS receiver. Tap **Setup ▸ Equipment**.
2. Tap **New**. Enter a configuration name and equipment information. Press **Next**.

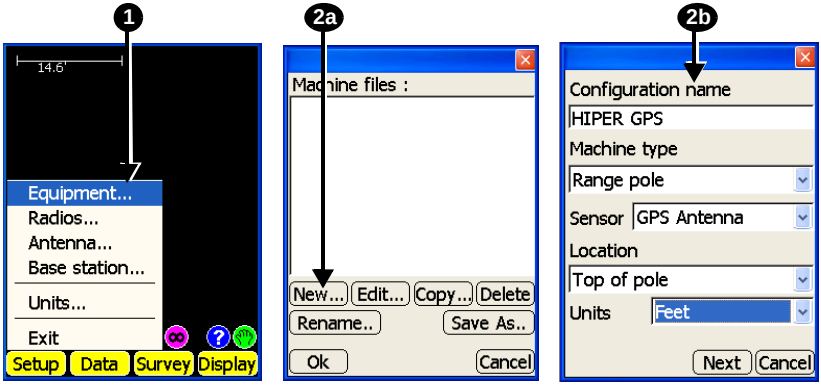


Figure B-5. Enter Configuration Type

3. Enter antenna information for the range-pole. Press **Next**.
4. Enter radio information. Press **Next**.

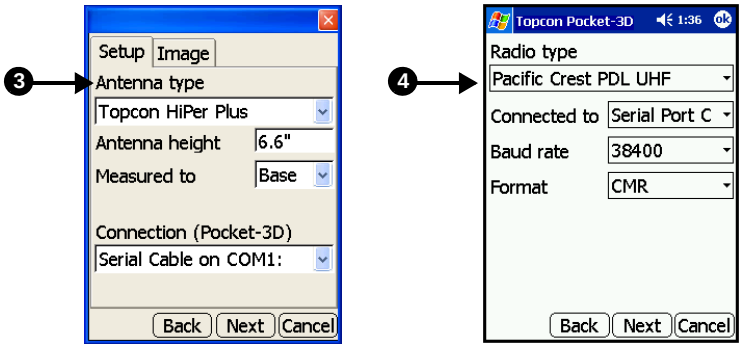


Figure B-6. Enter Antenna Information and Measurements

5. Select the configuration and press **Ok**. Press **Yes**.

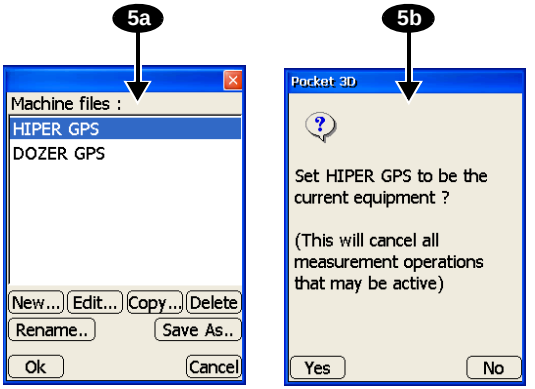


Figure B-7. Enter Radio (and mmGPS Information); Set As Equipment

Step 4: Setup the Rover Radio

Configuring the range pole Rover radio (Figure B-8) ensures proper communication with the Base.

1. Tap **Setup** ▸ **Radios**.
2. Select the radio type and enter its communication settings. If needed, press **Configure** to select the channel.
3. Press **Ok**.

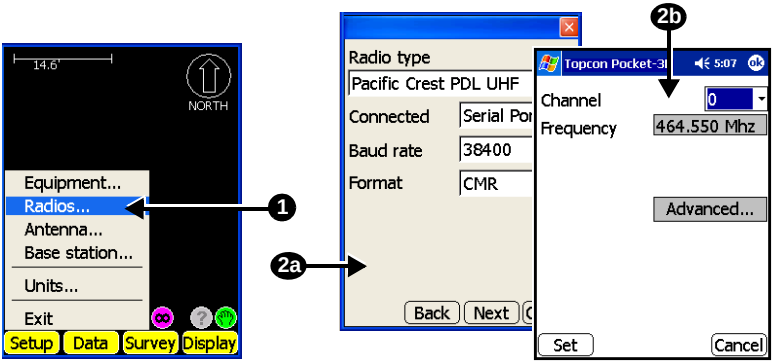


Figure B-8. Enter Radio Parameters

Step 5: Setup the Rover Antenna

Setup the Rover antenna's type and measurements (Figure B-9).

1. Tap **Setup** ▸ **Antenna**.
2. Select the type of antenna and enter its measurement information. Press **Ok**.

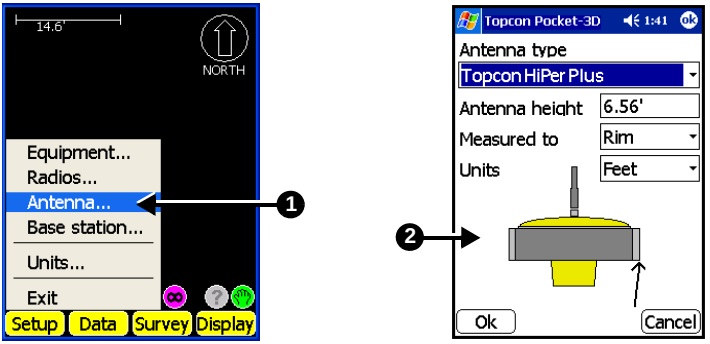


Figure B-9. Enter Antenna Information for GPS+ (or mmGPS Rover)

Step 6: Connect to the Rover

After setting up the rover, connect to the GPS receiver to begin using Pocket-3D at the jobsite (Figure B-10 on page B-8).

1. On the main screen, tap the **GPS setup** button.
2. Once the connection has been established, press **Ok**.

Notice that the GPS setup button changes color from red to green, indicating successful communication between the Base and Rover.

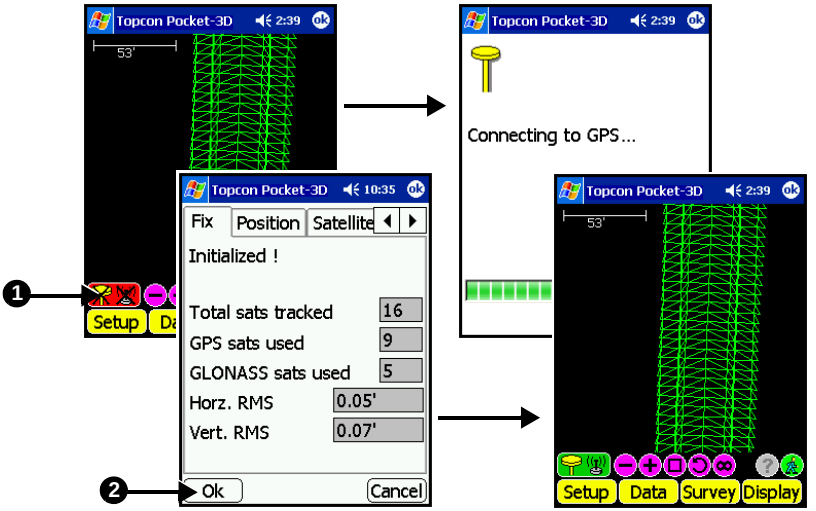


Figure B-10. Connect to GPS

Localizing with Pocket-3D

After setting up the Base Station, localize the jobsite coordinates with GPS+ coordinates.

1. Ensure the control point file for the jobsite is selected (**Data ▸ Control**) and select the equipment configuration for the current setup (**Setup ▸ Equipment**) (Figure B-11 on page B-9).
2. Tap **Data ▸ Control ▸ Control points**. Select the point to edit and press **Edit**.
3. Check the local coordinates and press the **GPS** tab.

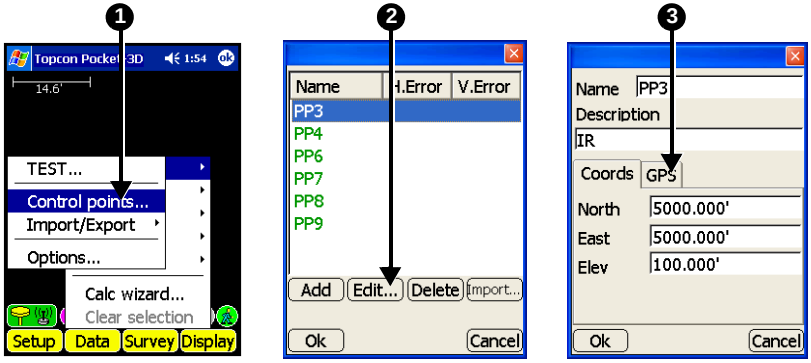


Figure B-11. Select Control Point to Localize

4. Enable "Use horizontal" and "Use Vertical" and press **Measure**. Press **Ok** to save the measurement (Figure B-12).
5. Repeat steps 2, 3, and 4 for each control point.
6. View the results and press **Ok** to save the control point file.

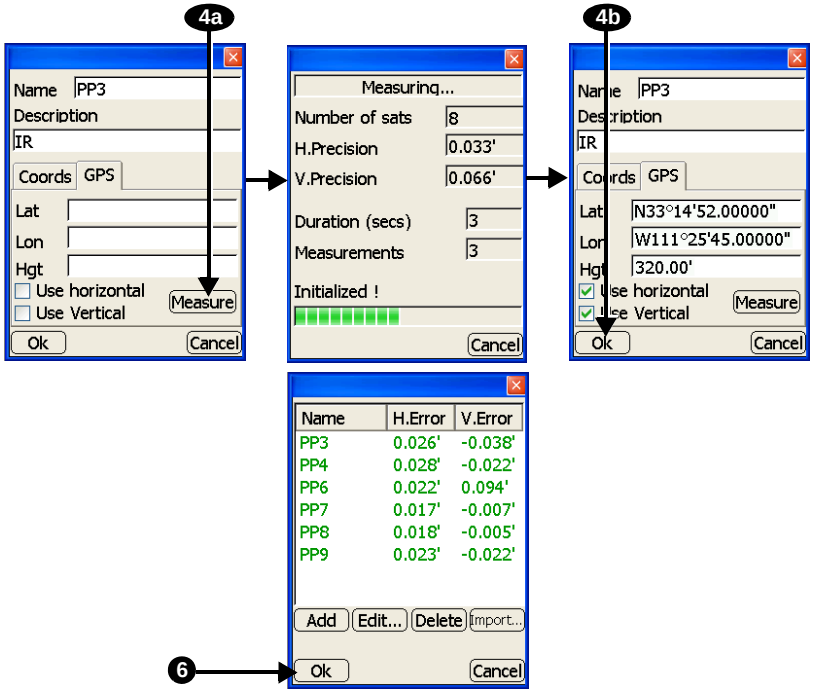


Figure B-12. Localize Control Points

Creating Files in Pocket-3D

In preparation for collecting point and polyline data, create a points file and a linework file for the jobsite.

Creating a Points File

1. Tap **Data** ▸ **Points** ▸ **[<none> or file name]**. Press **New**.
2. Enter a name for the points file and press **Ok**.
3. Press **Layers**.

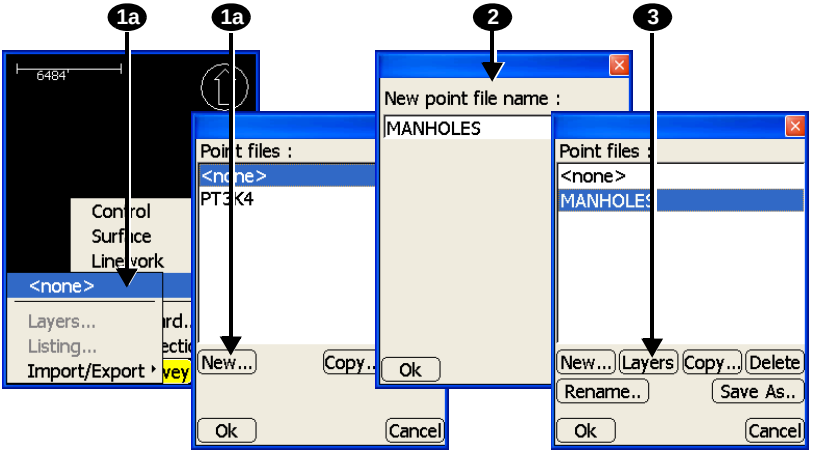


Figure B-13. Create Points File

4. Press **New**. Enter a name for the layer and the layer's parameters. Press **Ok** (Figure B-14 on page B-11).
5. Repeat step 4 for any other layers.
6. Press **Ok** to save the file. Press **Yes** to apply the file to the current jobsite.

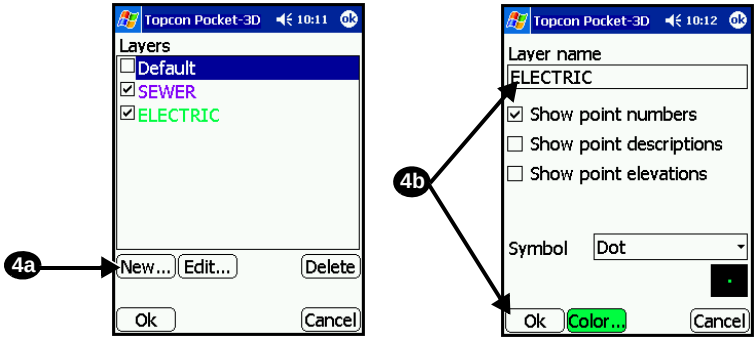


Figure B-14. Add Layers to Points File

Creating a Linework File

1. Tap **Data** ▸ **Linework** ▸ **[<none> or file name]**. Press **New** (Figure B-15).
2. Enter a name for the linework file and press **Ok**.
3. Press **Layers**.

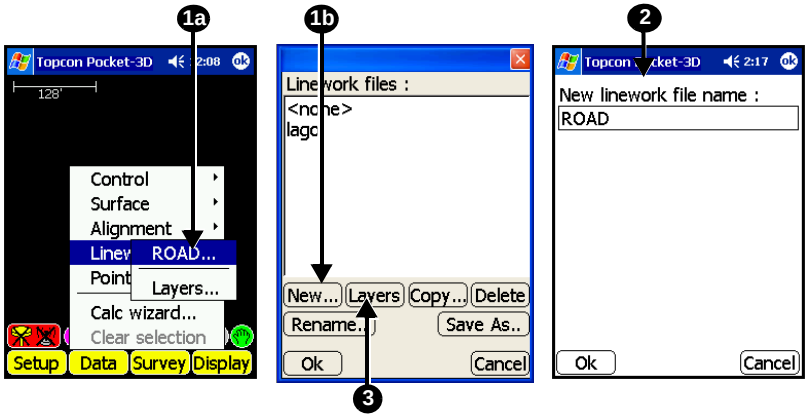


Figure B-15. Create Linework File

4. Press **New**. Enter a name for the layer and the layer's parameters. Press **Ok** (Figure B-16 on page B-12).
5. Repeat step 4 for any other layers.

6. Press **Ok** to save the file. Press **Yes** to apply the file to the current jobsite.

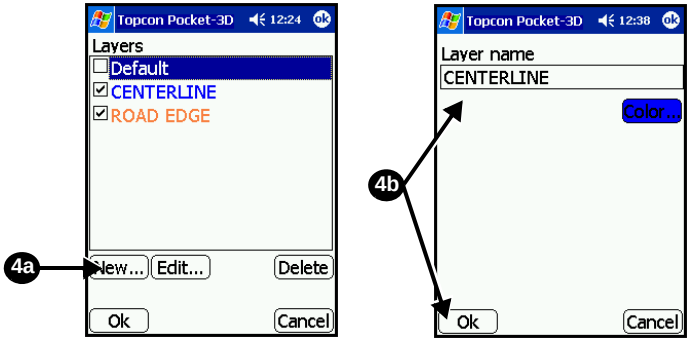


Figure B-16. Add Layers to Linework File

Collecting Data

Pocket-3D can be used to collect points, create polylines, or measure a control point. When collecting data, the project must be localized.

Collecting Points

The following procedure collects individual points (Figure B-17 on page B-13).

1. Tap **Survey** ▸ **Measure pts** ▸ **Topo-shot**.
2. Enter a point number and point descriptor.
3. Select a layer in which to add the point.
4. Press **Ok** to measure the point and return to the main screen.

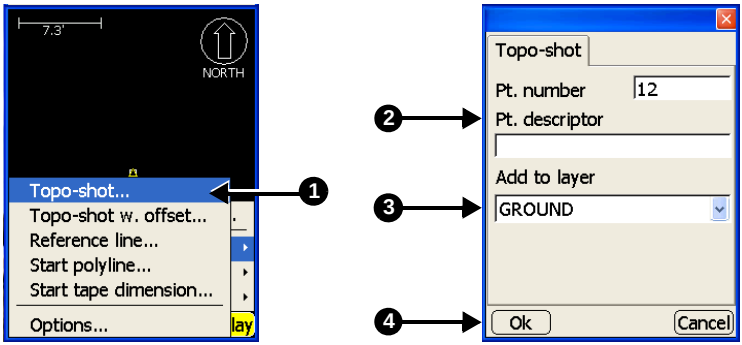


Figure B-17. Measure a Point

Creating Polylines

The following procedure collects points along a line, creating a polyline in a linework layer (Figure B-18 on page B-14).

1. Tap **Survey ▸ Measure pts ▸ Start polyline**.
2. Select a layer in which to add the polyline.
3. Press **Ok** to collect the point.
4. Move to the next point and press the **Enter** button on the controller to collect the next point. Repeat this step for all points in the polyline.
5. At the end of the polyline, tap **Survey ▸ Measure pts ▸ End polyline**.
6. If collecting three or more points to create a closed polygon, tap **Survey ▸ Measure pts ▸ Close polyline** to connect the first and last points.

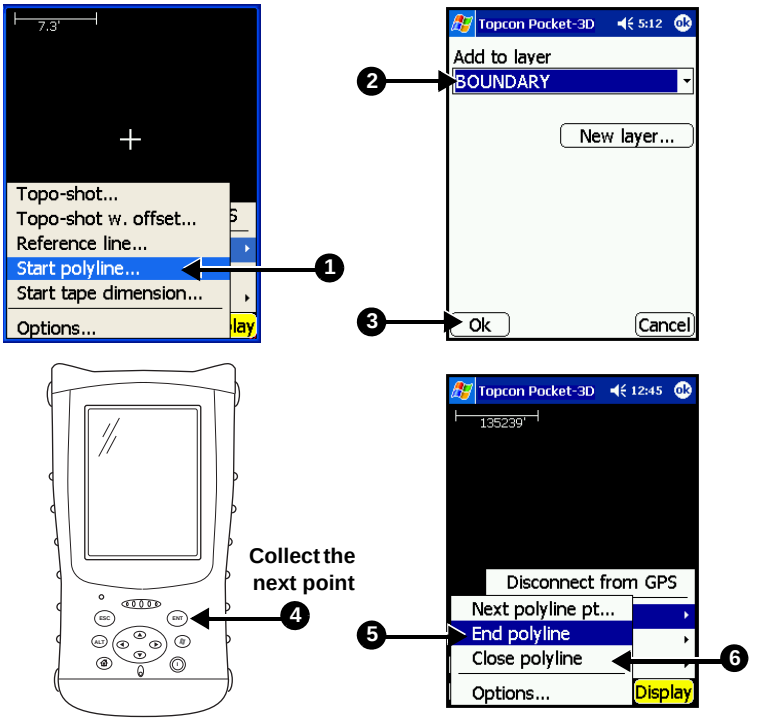


Figure B-18. Collect a Polyline (Using Pocket-3D on an FC-100 Controller)

Performing a Survey

The following procedure is for performing an auto-topo survey based on distance traveled (Figure B-19 on page B-15).

1. Tap **Survey** ▸ **Auto-topo** ▸ **By distance**.
2. Enter a minimum distance for measuring points and select a method to check the distance between points.
3. Select a layer in which to add the surveyed points and enter a point number to start with. If desired, enter a point descriptor.
4. Press **Start** to collect the first point.
5. Travel in a regular pattern to survey the desired area.
6. When done, tap **Survey** ▸ **Stop auto-topo**.

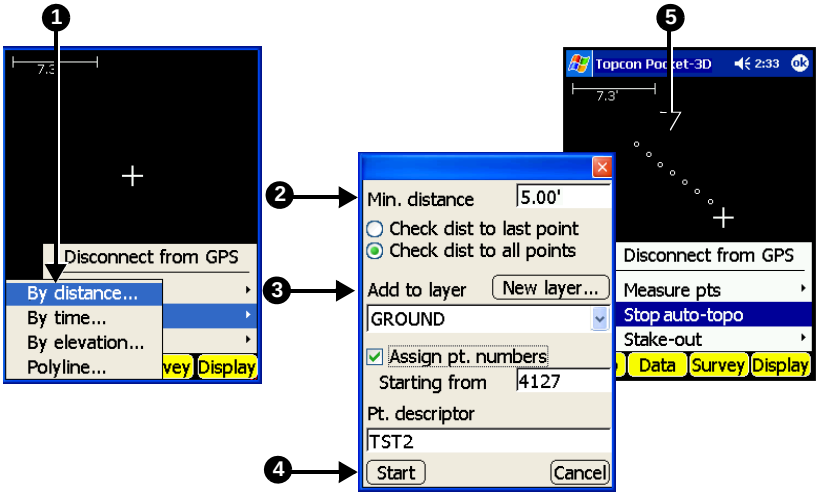


Figure B-19. Perform an Auto-topo Survey by Distance

Performing a Stakeout

Among the most common stakeouts performed with Pocket-3D are point and surface check stakeouts.

Staking out Points

1. Tap **Survey ▸ Stake-out ▸ Point list**.
2. Select the layer and the point to stakeout. Press **Ok**. If needed, travel to the point using the main screen directions.
3. Position the Rover at the point and tap **Survey ▸ Stake-out ▸ Measure stake**. After measuring the point, view the results.
4. To stakeout the next point in the list, press **Next** (Figure B-20 on page B-16).

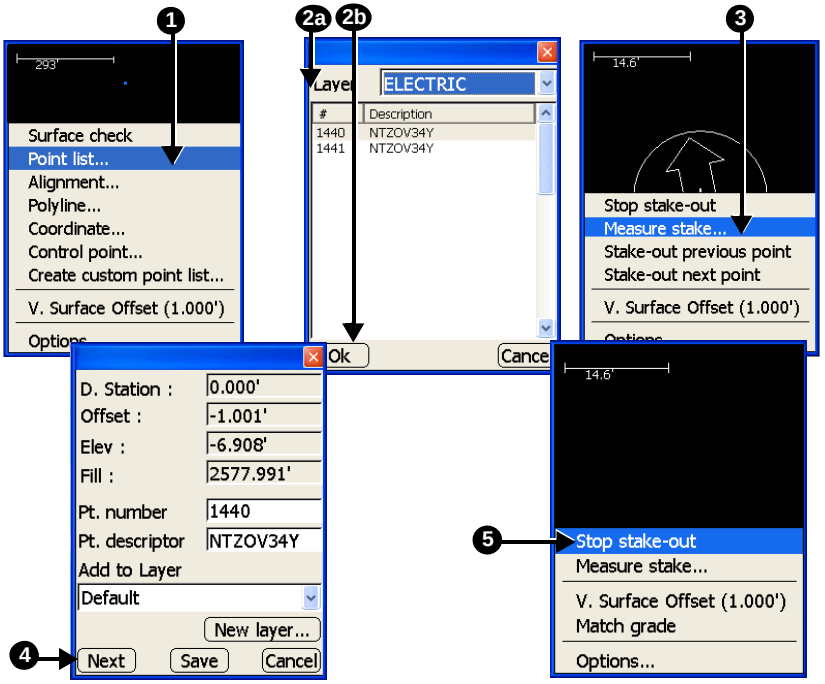


Figure B-20. Stakeout Point

5. To stop the stakeout, press **Ok** and tap **Survey ▸ Stakeout ▸ Stop stake-out** (Figure B-20).

Checking the Surface

1. Tap **Survey** ▸ **Stake-out** ▸ **Surface check** (Figure B-21).
2. View the cut or fill and current elevation.
3. Tap **Survey** ▸ **Stake-out** ▸ **Stop stake-out**.

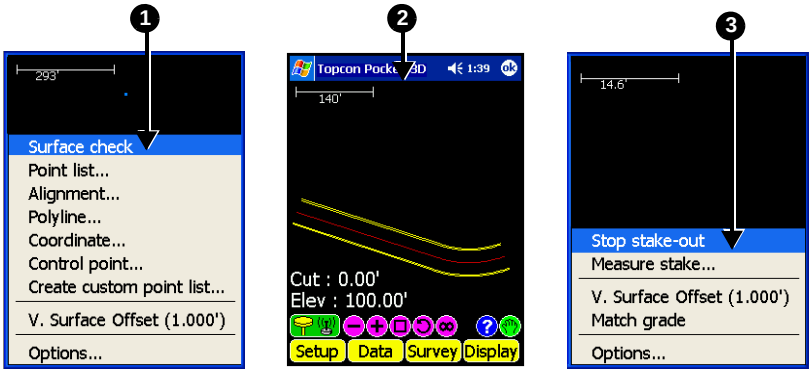


Figure B-21. Perform a Surface Check

Calculating the Inverse Between Two Points

An inverse calculation in Pocket-3D calculates the opposite direction and distance between two points (Figure B-22 on page B-18).

1. Tap the Selection Window icon and drag a selection box around two points.
2. Tap **Survey** ▸ **Calc wizard**.
3. With "Inverse between two pts" selected, press **Next**. The results of the calculation display.
4. Press **Cancel** to exit the ***results*** screen.
5. Tap **Survey** ▸ **Clear selection**.

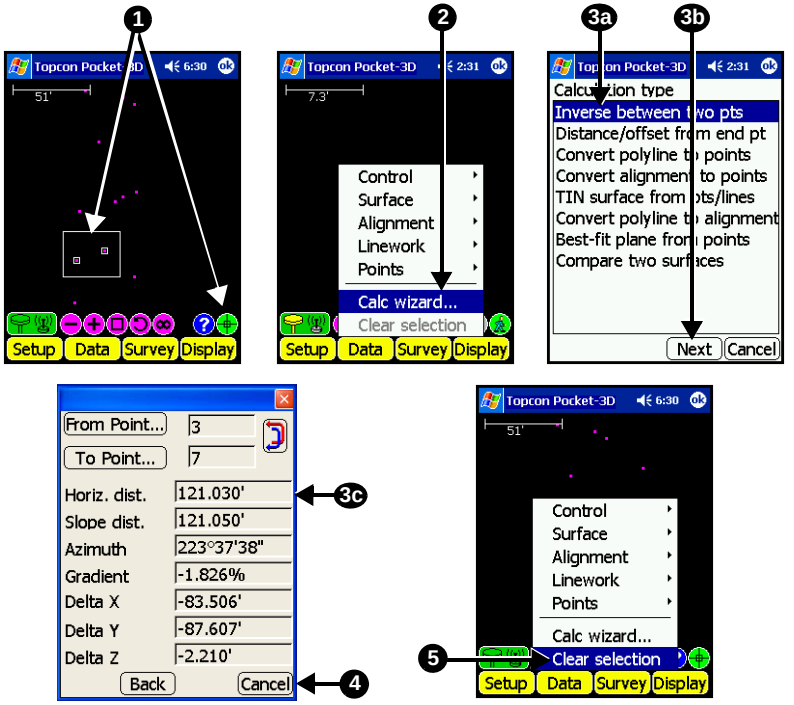


Figure B-22. Perform an Inverse Calculation

Safety Information

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

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 jobsite. Working around heavy construction equipment can be dangerous.
3. DO NOT attach 3Dxi brackets or hose connections while the machine is running.
4. DO NOT allow any 3Dxi component to limit the visibility of the operator.
5. Use Ty-wraps, supplied with 3Dxi, 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.

Relieve all pressure in the hydraulic lines before disconnecting or removing any lines, fittings or related components. If injury does occur, seek medical assistance immediately.

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

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

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

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

9. 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.
10. Keep the Carrying Case dry at all times.

DO NOT allow moisture to get inside the case. Moisture trapped in the case can adversely affect components.

If moisture does enter the Carrying Case, leave it open and allow it to dry thoroughly before storing any components.

General Usage Warnings

If any 3Dxi component has been dropped, altered, transported or shipped without proper packaging, or otherwise treated without care, erroneous measurements, calculations, or display may occur.

Periodically test 3Dxi components to ensure accurate measurements and operation.

Inform TPS immediately if any product does not function properly.

Only allow authorized TPS warranty service centers to service or repair this product.

The touch screen and LCD on the GX-60 can be damaged if struck with sufficient force.

Base Station Precautions

TPS receivers are designed for machine control, survey, and survey related uses (that is, surveying coordinates, distances, angles and depths, and recording such measurements). This product should never be used:

- Without the user thoroughly understanding this manual.
- After disabling safety systems or altering the product.
- With unauthorized accessories.
- Without proper safeguards at the survey site.
- Contrary to applicable laws, rules, and regulations.

TPS receivers should never be used in dangerous environments. Use in rain or snow for a limited period is permitted.

Internal Battery Pack Warnings

For the Base Station or MC-2.5 Receiver Box:

Tampering with the internal batteries by end users or non-factory authorized technicians will void the receiver's warranty.

- Do not attempt to open the battery pack or replace it.
- Do not disassemble the battery pack.
- Do not charge in conditions different than specified.
- Do not use other than the specified battery charger.
- Do not short circuit.
- Do not crush or modify.

Never attempt to open the receiver's casing or replace the batteries! Lithium-Ion batteries can be dangerous if mishandled!

Do not incinerate or heat battery pack above 212 degrees fahrenheit (100 degrees celsius). Excessive heat can cause serious damage and possible explosion.

Notes:

Specifications

The sections in this appendix give the features and specifications for several of the physical components of 3Dxi™.

GX-60 Control Box

The GX-60 control box is the interface to the sensors, radio, and GPS antenna. Table D-1 lists specification details for the control box.

Table D-1. GX-60 Control Box Specifications

Housing	Cast aluminum
Weight	6 lb. (2.72 kg)
Display	VGA touch screen Color display with adjustable backlight and enhanced brightness 640 x 480
Supply Voltage	10 to 30 VDC
Operating Current	Typical: 3A at 10VDC with no peripheral equipment Maximum: 8A at 10VDC
Operating Temperature	-20° to +60°C (4° to 140° F)
Ports	USB (2) Ethernet (one port routed to two connectors) RS-485 RS-232 CAN (2) Digital inputs (2) Bluetooth (internal)

Table D-1. GX-60 Control Box Specifications (Continued)

Connectors	Two 19 socket MIL-C-5015 cylindrical connectors; gold plated contacts; conductive anti-corrosive plated housing
Switches	2 momentary push buttons: one for power on and one for power off
Cooling fans	1 external housing fan 1 internal processor fan
Operating System	Microsoft Windows® XP, embedded

Figure D-1 shows the GX-60 control box dimensions.

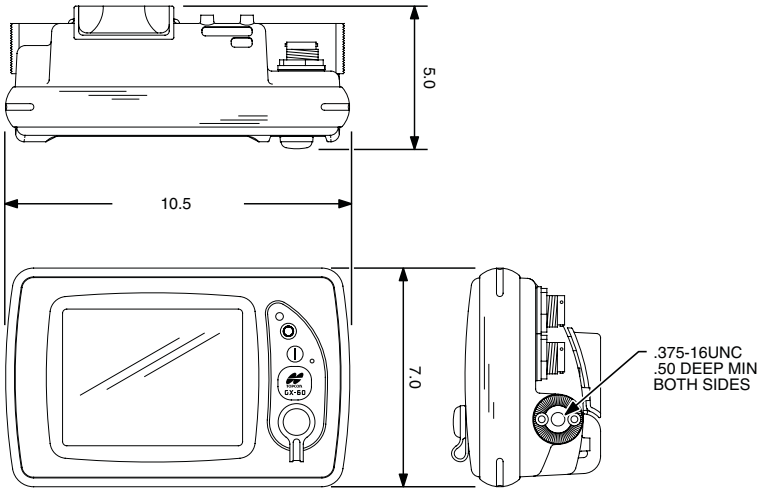


Figure D-1. GX-60 Control Box Dimensions

MC-2.5 Receiver Box

The Rover GPS MC-2.5 Receiver Box provides the industry's most advanced GPS and GLONASS (GPS+) dual-frequency satellite tracking system in a heavy-duty construction design with a shock absorbing mounting bracket. Four, high-power, bottom mounted magnets keep the receiver in place on machine. The receiver also features compliance with CMR and RTCM industry standards and has optional advanced multipath mitigation and optional in-band interference rejection.

Table D-2 lists specification details for the MC-2.5 Receiver Box.

Table D-2. MC-2.5 Receiver Box Specifications

Housing	Cast aluminum
Ports	3 each hardware-controller RS232C
Connectors	2 each 8 soc bayonet (with dustcaps) 3 each 11 soc bayonet (2 with dustcaps) 2 each N female 1 each reverse-TNC female
LEDs	Three LEDs: Radio transmission (red for no signal; green for signal); Two satellite status lights for Main and Aux (green for GPS)
Function buttons	Two function (FN) keys for switching information modes at the Main and Aux boards
Supply Voltage	10 to 30 VDC
Operating Current	10A max
Operating Temperature	0°C to +55°C
Weight	12.10 lb. (5.5 kg)
Radio	Built in UHF or Spread Spectrum
Radio Frequency Band	UHF 450 to 470 MHz Spread Spectrum 915

Figure D-2 shows the Machine GPS Receiver Box dimensions.

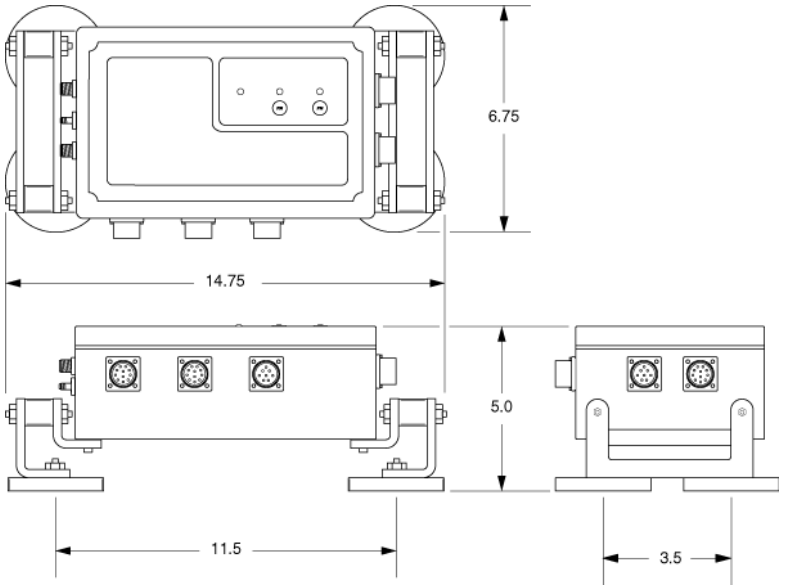


Figure D-2. MC-2.5 Receiver Box Dimensions

MC-A1 GPS Antenna (Machine)

The MC-A1 GPS Antenna is specifically designed with environmental sealing and shock isolation for use on the machine's blade. Table D-3 lists specification details for the MC-A1 GPS Antenna.

Table D-3. MC-A1 GPS Antenna Specifications

Supply Voltage	2.7–12VDC
Antenna Type	Zero-centered flat round plane
Housing	Aluminum ground plane and plastic dome
Connectors	N female
Mounting Clamp	ID 1.75 in
Mounting Thread	5/8 - 11 in

Table D-3. MC-A1 GPS Antenna Specifications (Continued)

Weight	1.9 lbs
Operating temperature	-20°C to +60°C
Phase Center Vertical Offsets	L1: 54.3mm L2: 60.5mm

Figure D-3 shows the dimensions of the MC-A1 GPS Antenna.

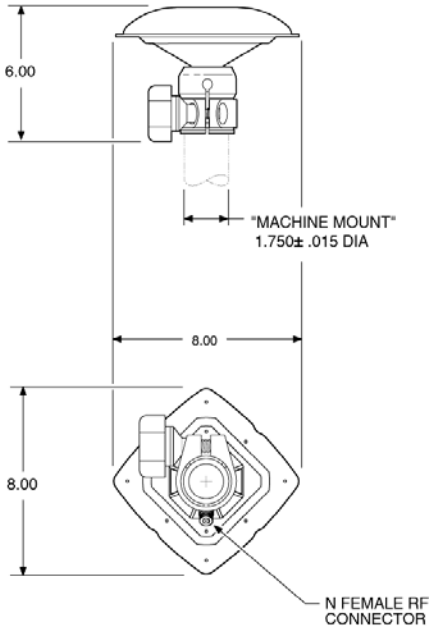


Figure D-3. MC-A1 GPS Antenna Dimensions

Notes:

Regulatory Information

The following sections provide information on this product's compliance with government regulations for use.

Radio Usage Information

All users must obtain an FCC (Federal Communications Commission) license before operating the GPS+ or 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 469MHz 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/

WEEE Directive

Following information is for EU-member states only:

The use of the symbol indicates that this product may not be treated as household waste. By ensuring this product is disposed of correctly, you will help prevent potential negative consequences for the environment and human health, which could otherwise be caused by inappropriate waste handling of this product. For more detailed information about the take-back and recycling of this product, please contact your supplier where you purchased the product or consult.

Warranty Terms

TPS laser and electronic positioning equipment are guaranteed against defective material and workmanship under normal use and application consistent with this Manual. The equipment is guaranteed for the period indicated, on the warranty card accompanying the product, starting from the date that the product is sold to the original purchaser by TPS' Authorized Dealers.[1]

During the warranty period, TPS will, at its option, repair or replace this product at no additional charge. Repair parts and replacement products will be furnished on an exchange basis and will be either reconditioned or new. This limited warranty does not include service to repair damage to the product resulting from an accident, disaster, misuses, abuse or modification of the product.

Warranty service may be obtained from an authorized TPS warranty service dealer. If this product is delivered by mail, purchaser agrees to insure the product or assume the risk of loss or damage in transit, to prepay shipping charges to the warranty service location and to use the original shipping container or equivalent. A letter should accompany the package furnishing a description of the problem and/or defect.

The purchaser's sole remedy shall be replacement as provided above. In no event shall TPS be liable for any damages or other claim including any claim for lost profits, lost savings or other incidental or consequential damages arising out of the use of, or inability to use, the product.

1. The warranty against defects in Topcon batteries, chargers, or cables is 90 days.

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