Field Guide

GEOSPATIAL
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SX10/SX12 SCANNING TOTAL STATION: IN-FIELD CALIBRATION

This document outlines the different field calibration procedures that can be performed on the Trimble SX10 or SX12 scanning total station. Regular calibration of the instrument will ensure more reliable and accurate measurements.

To set up the SX10 or SX12 for adjustment

1. Set up the instrument on a stable surface.
2. Connect the instrument to the controller running Trimble Access.
3. In Trimble Access, make sure that the instrument is accurately leveled and that the compensator is enabled. **Do not start a survey**.
4. Tap ☰ and select **Instrument** / **Adjust**.
5. Select the required calibration then follow the prompts to complete.
6. If any of the calibrations fail, or any error messages appear, ensure the instrument is stable and the specific calibration requirements are being met. Then repeat the process. If there is still an issue, contact your local Trimble Representative.

Available field calibrations

Note – *These calibrations are best performed with the latest instrument firmware installed, and using the latest version of the Trimble Access software.*

- *To be able to perform these adjustments on an SX12, the controller must be running Trimble Access version 2021.00 or later.*
- *To be able to perform the automatic camera collimation and the plummet camera calibration on an SX10, the SX10 must have firmware S2.1.9 or later installed and the controller must be running Trimble Access version 2018.20 or later.*

All field calibrations are available for the SX10 or the SX12, except for the laser pointer adjustments which are specific to the SX12.

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Compensator calibration

Purpose

The compensator calibration ensures that the instrument can adjust for the tilt of the instrument.

When to perform this adjustment

- Immediately prior to high precision measurements in one face.
- Whenever the instrument may have been roughly handled during transport.
- After extended working or storage periods.
- If there has been a significant temperature difference from the previous calibration.
- When you have a significant difference when turning the instrument 180°, between the absolute values for the sighting and trunnion on the **Electronic level** screen. For example, a difference of 8" (0.0025 gon) will cause a difference of 2 mm at 100 m.

Note – *Any measurement errors introduced by collimation, tilt, or trunnion axis errors are cancelled when two-face measurements are used.*

Setup instructions

It is important that the instrument has been powered on for at least 5 minutes before you start the calibration procedure to ensure that the compensator has warmed up.

Results

If the calibration fails, ensure you have a stable setup and repeat the calibration. If it fails again then contact your local Trimble Representative.

Autolock collimation

Purpose

Perform the Autolock collimation test to determine and store the tracker collimation error values in the instrument. The Autolock collimation correction values are then applied to all subsequent angle measurements observed when Autolock is enabled. Angles observed in a single face are corrected for collimation errors.

When to perform this adjustment

- Immediately prior to high precision measurements in one face.
- Whenever the instrument may have been roughly handled during transport.
- After extended working or storage periods.
- If there has been a significant temperature difference from the previous calibration.

Note – *Any measurement errors introduced by collimation, tilt, or trunnion axis errors are cancelled when two-face measurements are used.*

Setup instructions

- See To set up the SX10 or SX12 for adjustment for initial setup instructions.
- The compensator calibration should always be performed immediately prior to performing the Autolock collimation.
- Set up the prism at least 100 m from the instrument, and within 9° (10 gon) of horizontal. Ensure there are no obstacles between the instrument and the prism.
- Use a single prism for the collimation. Do not use a 360 prism.

Results

If the collimation fails, ensure you have a stable setup and repeat the collimation. If it fails again then contact your local Trimble Representative.

Telecamera auto focus adjustment

Purpose

This adjustment stores new values for the Telecamera auto focus motor in the instrument.

When to perform this adjustment

- Perform the Telecamera auto focus adjustment if you identify an issue with the auto focus of the Telecamera in the field, for example a fuzzy telecamera image.
- The Telecamera auto focus calibration does not need to be performed as frequently as other instrument adjustments, only if you identify a fuzziness with the telecamera image.
- No other adjustments need to be completed before performing the Telecamera auto focus adjustment.

Setup instructions

- This adjustment should be conducted with a target or object that has distinct lines/edges approximately 10 meters from the instrument and in good light conditions.
- Trimble recommends the laser adjustment plate, coaxial target (P/N 57013007) or similar.

Results

If the Telecamera auto focus calibration does not improve the auto focus, perform the adjustment again. If the auto focus is still out of focus, contact your local Trimble Representative.

Automatic camera collimation

Note – *To be able to perform these adjustments on an SX10, the SX10 must have firmware S2.1.9 or later installed and the controller must be running Trimble Access version 2018.20 or later.*

Purpose

Perform the **Automatic camera collimation** to determine and correct for collimation errors between Face 1 and Face 2 for the Overview, Primary or Telecamera cameras in the SX10 or SX12. Angles observed in a single face are then corrected for collimation errors.

During this process the instrument captures multiple images in both Face 1 and Face 2, evaluates the stability and quality of the images, and then calculates the collimation error through image matching between the Face 1 and Face 2 images.

When to perform these adjustments

- ***Important:*** *Each camera has its own calibration parameters and you should only calibrate the camera(s) that are exhibiting erroneous behavior.*
- The compensator calibration should always be performed immediately prior to performing the Automatic camera collimation.
- Camera collimations should not need to be performed frequently. The cameras are extensively calibrated in the factory and these calibrations are very stable over time and changes in temperature.
- You should perform the Automatic camera collimation if you notice any of the following:
  - If you observe deviations between the camera image and measured points. For a detailed camera check procedure using Trimble Access and Trimble Business Center, refer to the *Camera Calibration Check Procedure for SX10 Product Bulletin*.
  - If you aim to an object in Face 1, switch to Face 2, and you can clearly see that the crosshairs do not align properly.
  - During scanning if the scans are colorized and you can see a mismatch between colorization of scan points and overlaid images.

Setup instructions

Before performing the **Automatic camera collimation**, make sure you are familiar with the Camera collimation and calibration best practices, page 9.

In summary, the selected target scene, which is everything inside the frame drawn on the video feed, requires:

- Objects that have clear features in two different directions. For example a horizontal and vertical line.
- All objects should be in the same depth of field, with no more than 5% difference in the distance to all objects.
- Avoid shiny or reflective objects that are reflecting other objects.
- All objects within the frame must be static for the duration of the calibration. There should be no movement, such as objects moving in the wind or moving traffic behind objects.
- For easier target identification, use the second zoom level for the selected camera to maximize the frame size and make it easier to identify the target. For the:
  - **Overview** camera, use zoom level 2.
  - **Primary** camera, use zoom level 4.

    - **Telecamera**, use zoom level 6.
- To achieve the best collimation results, set up or choose a target at the recommended distance for the selected camera. For the:
    - **Overview** camera, select a target at a distance of 10 m (33 ft).
    - **Primary** camera, select a target at a distance of 20 m (66 ft).
    - **Telecamera**, select a target at a distance of 50 m (164 ft).

Before starting the collimation, Trimble recommends changing the instrument face, to ensure that the chosen object within the frame looks the same in both faces. If it does not, then it is likely that the calibration will fail, so you should choose a different target.

Results

The image matching threshold is 0.5 pixels for the Overview and Primary cameras, and 0.8 pixels for the Telecamera. This threshold is used to determine suitable images from which to do the calibration and exclude outliers. The overall standard deviation of the calibration will be within this tolerance, but is typically around 0.2 pixels.

The size of a pixel depends on the camera used and the distance to the target. At a distance of **25 m** (82 ft) to the target, **1 pixel** equates to:

- 10 mm (0.39 in.) with the **Overview** camera.
- 2.2 mm (0.08 in.) with the **Primary** camera.
- 0.44 mm (0.02 in.) with the **Telecamera**.

If the Automatic camera collimation fails or any error message appears, there may be issues with the selected target scene. See Camera collimation and calibration best practices and if required make the appropriate changes to the selected target scene. If there is still an issue, contact your local Trimble Representative.

Resetting to factory default

To reset the collimation to the factory default setting, select the camera and then tap **Reset** in the **Automatic camera collimation** screen.

Plummet camera calibration

Note – *To be able to perform this adjustment on an SX10, the SX10 must have firmware S2.1.9 or later installed and the controller must be running Trimble Access version 2018.20 or later.*

Purpose

Perform the **Plummet camera calibration** to calculate and correct to the rotational center of the plummet camera. The plummet camera image is then shifted to correspond to the center pixel for the camera sensor. This calibration ensures that the crosshairs are in the same location, regardless of instrument orientation.

When to perform this adjustment

- ***Important:*** *Each camera has its own calibration parameters and you should only calibrate the camera(s)that are exhibiting erroneous behavior.*
- The Plummet camera calibration should not need to be performed frequently. The camera is extensively calibrated in the factory and these calibrations are very stable over time and changes in temperature.
- Carry out this adjustment if you set up the instrument over a target and when you rotate the instrument you notice that the plummet camera crosshairs scribe a circle, instead of remaining in the same position.

Setup instructions

Before performing the Plummet camera calibration, make sure you are familiar with the Camera collimation and calibration best practices, page 9.

In summary, the selected target scene, which is everything inside the frame drawn on the video feed, requires:

- Objects that have clear features in two different directions. For example a horizontal and vertical line.
- All objects should be in the same depth of field, with no more than 5% difference in the distance to all objects.
- Avoid shiny or reflective objects that are reflecting other objects.
- All objects within the frame must be static for the duration of the calibration. There should be no movement, such as objects moving in the wind.
- To achieve the best collimation results, set up the target at the furthest distance possible. To do this, set up the instrument as tall as practical within the plummet camera working range (1.0–2.5 m) while still maintaining a stable setup.

Results

If the Plummet camera calibration fails or any error message appears, there may be issues with the selected target scene. See Camera collimation and calibration best practices and if required make the appropriate changes to the selected target scene. If there is still an issue, contact your local Trimble Representative.

The image matching threshold is 0.5 pixels, so all calibration results will be within this tolerance. For the plummet camera, the size of one pixel depends on the instrument height. At an instrument height of 1.55 m (5.08 ft), 1 pixel equates to 0.2 mm (0.008 in.).

Resetting to factory default

To reset the calibration to the factory default setting, tap **Reset** in the **Plummet camera calibration** screen.

Camera collimation and calibration best practices

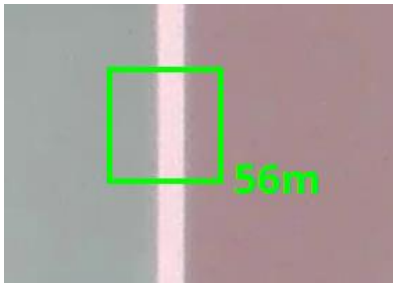
While the calibration procedure will fail rather than provide a poor result, there are some key considerations to ensure you get a successful calibration with the best results possible.

The collimation and calibration calculations are only done on a small area of the overall image, as shown by a central square overlay on the video feed in Trimble Access. The considerations below only need to be considered for what is contained within this central square.

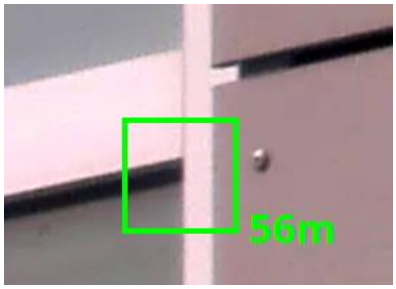
Use clear, 2D features

Select objects that have clear features in two different directions, for example a horizontal and vertical line. Choose a target that is in clear focus for the camera you are calibrating.

Poor choice



Good choice



Stable target

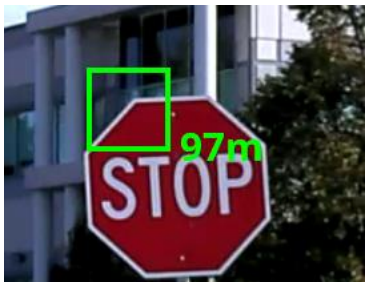
The chosen target must be stable. Avoid moving objects behind or around the target, for example moving traffic or wind causing the target to move. Movement means the target will be in different places in different images, which causes the target matching to fail.

Consider depth of field

Avoid focusing on multiple objects at different depth of field, particularly when calibrating the Overview or Primary cameras. As a guide, make sure there is no more than 5% difference in the distance to all objects in the target scene. For example, the corner of a building may not be a good target as there may be objects behind the building captured in the scene that are at a significantly different distance.

Check that the distance shown beside the frame box matches the distance to the target you are calibrating with, as opposed to an object behind or in front of the intended target. Otherwise the calibration will succeed given that there is a valid distance and a valid target but it will give a large calibration value since the target and distance are significantly different.

Poor choice



Good choice

Check Face 1 compared to Face 2

Before starting the calibration, check that the object looks the same in Face 1 and Face 2 and is not obscured, for example by the instrument handle. If the object does not look the same in both faces, then it is likely that the calibration will fail, so you should choose a different target. For the Overview and Primary camera this is particularly important, given the offset of the cameras from the center of the telescope.

Face 1

Face 2

Contrast / lighting conditions

Select objects that provide good contrast. Avoid shiny or reflective objects that are reflecting other objects in the image, for example a shiny car that is reflecting other objects in the paint. Reflected objects will be reflected at different distances and will appear in different locations in Face 1 and Face 2.

Distance recommendations

The distance of the target at which the best calibration and collimation results will be achieved depends on the camera selected for adjustment. This is because the collimation error for the cameras is not the same at all distances. In the user calibration there is a distance dependent collimation error that is slightly larger at shorter distances. The error converges at these specified distances and therefore will give the best calibration results for all distances for that camera. For the:

- **Overview** camera, select a target at a distance of 10 m (33 ft).
- **Primary** camera, select a target at a distance of 20 m (66 ft).
- **Telecamera**, select a target at a distance of 50 m (164 ft).
- **Plummet** camera, select a target at the furthest distance possible within the range 1.0–2.5 m (3.2–8.2 ft).

Target ideas

There is no need to use a specific target as the collimation or calibration will work with any object that meets the requirements above.

Automatic camera collimation errors

The following error messages may appear when completing any of the automatic camera collimation routines.

1 – Unable to Measure Distance to Target

This occurs when the initial distance to the target is returned which allows the procedure to begin, but during the procedure distances are no longer returned. Examples include the telescope becoming covered during image capture, or pointing at a black/moving/reflective surface which gives only intermittent distance returns.

2 – Please choose another target which is not reflective, moving or too close

This occurs when the target is moving and image capture on Face 1 fails. Causes could be using target objects that include moving leaves in a tree, grass in the wind, heat shimmer interference or a moving road sign in the wind. This could also be caused by an unstable instrument or if manual focus is on (for the Telecamera) and its not in focus, or if a Telecamera auto focus adjustment is required to improve the auto focus.

3 – There were problems matching images from each face. Please choose another target which is not reflective, moving or too close

This occurs when the image capture or matching fails between Face 1 and Face 2, or occasionally even on Face 1 only. Causes could be movement in front of the target, targets at a different depth of field between the Face 1 and Face 2 or if the handle of the instrument is captured in Face 2 pictures – i.e. using a low VA angle on F1.

4 – Bad calibration target. Please choose a target with clear horizontal and vertical features.

The calibration failed due to the lack of a suitable target. Causes could be a plain target with no features, a moving instrument or an out of focus target.

5 – Instrument connection lost during calibration. Please try again.

This occurs if the controller loses connection to the SX10 or SX12 during the procedure and does not reconnect until after the procedure is complete. Please ensure a stable instrument connection and retry the calibration.

6 – Instrument was moved or obstructed from moving during calibration procedure

This occurs when the instrument is either prevented from moving automatically or is turned manually during the collimation.

Plummet camera calibration errors

The following error messages may appear when completing the plummet camera calibration routine.

1 – There were problems matching images from each face

The calibration failed due to a change in target during calibration. Causes could be a movement of the instrument, a slightly moving target (for example, grass moving in the wind), or moving shadows across an otherwise suitable target.

2 – Bad calibration target. Please choose a target with clear horizontal and vertical features

The calibration failed due to the lack of a suitable target. Causes could be a plain target with no features, a moving instrument or an out of focus target.

3 – Instrument connection lost during calibration

This occurs if the controller loses connection to the SX10 or SX12 during the procedure and does not reconnect until after the procedure is complete. Please ensure a stable instrument connection and retry the calibration.

4 – Instrument was moved or obstructed from moving during calibration procedure.

This occurs when the instrument is either prevent from moving automatically or is turned manually during the calibration.

Laser pointer collimation

Purpose

Perform the **Laser pointer collimation** to determine and correct for collimation errors between Face 1 and Face 2 for the laser pointer in the SX12. The angles to the laser pointer location in a single face are then corrected for collimation errors.

When to perform this adjustment

You should perform the laser pointer collimation if you aim to an object in Face 1 with the laser spot, switch to Face 2, and you can clearly see that the laser spot does not align properly. Or in the following scenarios:

- Immediately prior to high precision measurements in one face.
- Whenever the instrument may have been roughly handled during transport.
- After extended working or storage periods.
- If there has been a significant temperature difference from the previous calibration.

Note – *Any measurement errors introduced by collimation, tilt, or trunnion axis errors are cancelled when two-face measurements are used.*

Setup instructions

Choose a DR target over 30 m away where you can clearly see the laser spot. An angles only measurement will be taken on each face.

Results

The collimation value can be a maximum of 60". If you get a larger collimation adjustment value then please contact your local Trimble Representative.

Resetting to factory default

To reset the collimation to the factory default setting, tap **Reset** in the **Laser pointer collimation** screen.

Laser pointer auto focus

Purpose

This adjustment stores new values for the Laser auto focus motor in the instrument.

When to perform this adjustment

- Perform the Laser focus calibration if you identify an issue with the auto focus of the laser spot in the field, for example a blurry laser pointer spot.
- The laser focus calibration does not need to be performed as frequently as other instrument adjustments, only if you identify a fuzzy or blurry laser spot.
- No other adjustments need to be completed before performing the Laser focus calibration.

Setup instructions

Choose a DR target over 30 m away where you can clearly see the laser spot.

Results

If the laser pointer auto focus calibration does not improve the clarity of the laser spot, perform the adjustment again. If the auto focus is still out of focus, contact your local Trimble Representative.