Automated Precision Incorporated

TrackerCal3 Software
USERS MANUAL

For use with Models LTS-1000 and LTS-1100
V. 1.3.5

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Software Installation

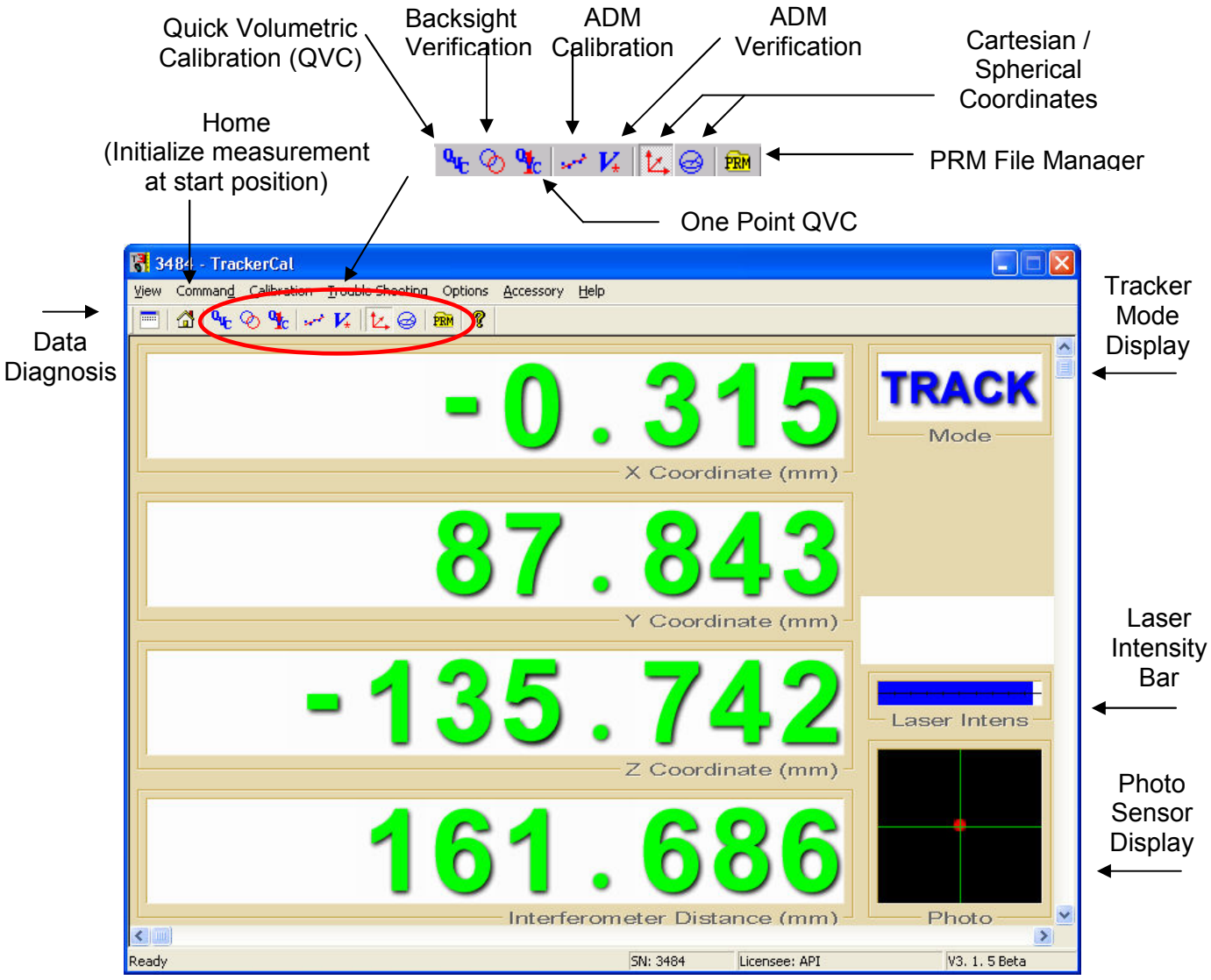
The tracker is delivered with two software packages: the API TrackerCal3Software (for maintenance) and a third party geometric analysis package as appropriate for the user's applications. If your computer was included as part of your order from API, the calibration software, and the geometric analysis package is pre-installed. To Install the TrackerCal3 software, insert the API calibration software CD into your computer, open the file explorer to view the CD-ROM drive, and double click on the "TrackerCalib.exe" file (note: actual name of file may be slightly different depending on version number). The setup program will guide you through the installation process.

Starting Software (TrackerCal3)

To initialize the tracker program double click on the "TrackerCal3 " icon located on the desktop. If the icon is not present the software may be run from the start menu under "Programs: API Laser Tracker System". When the program begins, the Tracker will cycle through an index search mode of the encoders on the tracker unit. (NOTE: the system index only occurs the first time after the system has been powered on, or reset). As soon as the search index pulse is found, the program will proceed to the main operations screen. Please note that the laser head must be allowed to warm up for one half hour to achieve best accuracy. The laser distance display will indicate that the laser is warming up. Once the laser is ready, the laser distance reading will display a numerical value, and the green led on the tracker head will light up.

Software Operation

The main operations screen contains various graphical information views that provide the user with data feed back from the tracker in addition to two tool bars and the main menu. The screens are described below (see fig. 2):



Coordinate Screen – The target location screen shows the position of the target in terms of the active coordinate system, which may be toggled, between Cartesian, cylindrical, or spherical coordinates. The distance from the laser head to the target is always displayed.

Laser Intensity Bar – This displays the intensity of the beam received back from the target. Signal integrity must be maintained in order to guarantee valid measurements. If the signal is lost, the main screen will display the azimuth and elevation angles only. See section 3.2.2.4 for procedures on relocation of the target.

Photo Sensor Display - The red dot shows the active tracking signal from the photo sensor in the laser head. This indicator will move off of center as the SMR is moved and the laser head adjusts to track it. The dot should show no significant movement if the SMR is fixed at a stable location.

Tracker Mode Display – This display block shows the current operating mode of the tracker. A table of operating conditions and their definitions is shown at the right.

Tracker Mode	Definition
Servo free	Indicates that the servo system is disengaged
Stand-by	Indicates that the servo system is engaged and ready to begin tracking or manual jogging.
Tracking	The system is currently tracking the target position.
Base AZ / EL limit	Indicates that the tracker servo system has reached a program soft limit in either the azimuth or elevation direction.
Lost Target	This indicates that the laser signal received by the tracker head has fallen below the level needed for active tracking.
Homing	Indicates that the tracker is servoing to a Home position.
Warming Up	Indicates that the laser is warming up.

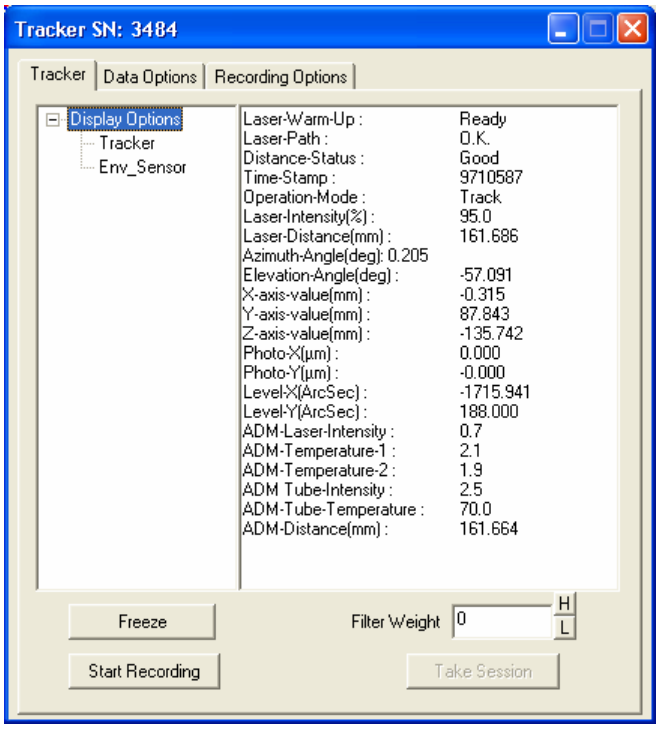
The bottom of the screen displays prompts from the software as well as the following parameters for the Tracker:

- SN – Serial Number of the Tracker
- Licensee – Owner of the software license for the tracker.
- Running Time- Indicates duration of tracker activity after the software application has started.

Main Menu & Software Functions

The main menu contains a number of basic functions. The operators will need to use only two of the functions to evaluate the system performance. Those functions are the **Front sight / Back sight** and the **Quick Volumetric Calibration** functions.

Diagnosis Dialog Box



Evaluating System Performance

Before using the laser tracker, it should always be checked for system accuracy and performance. This is done by monitoring the system sensors and by running a **One Point QVC** (or **Front sight / Back sight)** measurement. On models equipped with an ADM system, the ADM Verification tool is also used to check ADM system accuracy.

Monitoring the system sensors

Click on the Data Diagnosis icon from the Toolbar or select it from the View menu. This will open a dialog box displaying the raw system data. Given this information the user should check the following conditions:

Check the Laser Intensity:

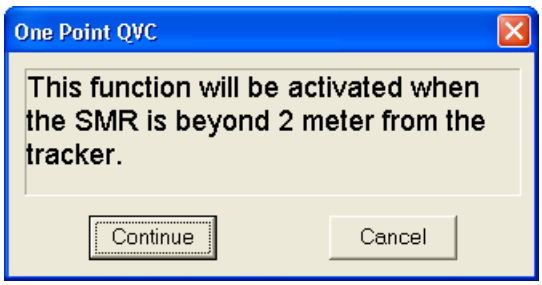
1. Track the SMR out to about 5 meters
2. Observing the Laser Intensity Display, it should decrease no more than 20%
3. Open the Data Diagnosis window and note the raw intensity values

Check the Weather Station

With the Data Diagnosis Window open, Click on the Env_Sensor Tab and verify that the temperature and pressure parameters are active and updating.

One Point QVC

The "One Point QVC" is the main field-adjustment tool for the Tracker3. It is the volumetric compensation and backsight check simplified into a single tool. As the name implies, the "One Point QVC" requires only a single point to compensate the same six error parameters as the full QVC (see below). QVC stands for "Quick Volumetric Compensation." Most any point can be used with the single point QVC method, the only requirement is that the point be at least 2 meters away from the Tracker3 system. This two meter range gives a much better statistical assumption to compensate the full working range of the instrument than similar calibrations that are performed on the body of the instrument itself. For best practice, it is usually most meaningful to run the "One-Point Quick Volumetric Compensation" at a point in the expected



working volume of your job.

To start the One Point QVC, go to the Calibration menu and select "One Point QVC". A dialog box will open reminding you that the procedurebe activated when the SMR is beyond 2 meters (6.5 Feet). Click "Continue" to proceed or cancel to stop the procedure.

SOFTWARE TIP: *The Measure button will be unavailable until the SMR is moved beyond the 2-meter requirement.*

A second dialog box will appear prompting you to put the SMR at least 2 meters from the tracker. This point can be at any angle as long as the distance is greater than 2 meters. Click the button labeled "Measure" to proceed. The Tracker will then take a single reading from the frontsight and backsight positions. The difference between the two measurements will be displayed in the "Angle Difference" column (similar to the backsight accuracy dialog).

After the measurement is complete, press the "Update" button to apply the compensation to the tracker's parameter file. From this point, the procedure is the same as the standard QVC detailed below (see Saving QVC Data).

Backsight Accuracy Check Overview

By simply measuring the Backsight angle of several targets throughout the work volume, the user can quickly evaluate tracker calibration status. When the backsight measurements are taken, the angle difference between subsequent measurements should be less than 0.004 degrees. Typical values are better than 0.001 degrees.

IMPORTANT NOTE: *A backsight accuracy check or **One Point QVC** (which includes the Backsight Check) should be performed at the start of any new measurement job.*

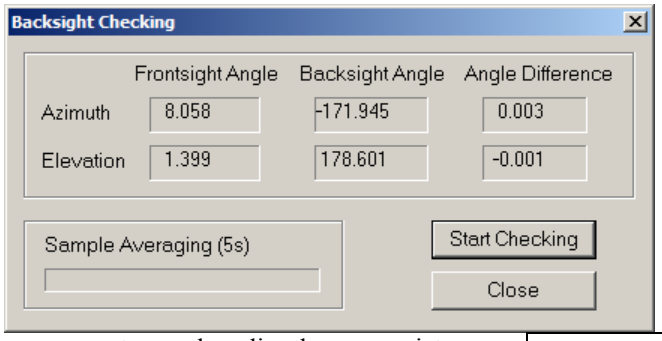
Backsight Accuracy Check Procedure:

4. Track the SMR out to a stable nest at least 3 meters away from the tracker
5. Click on the Backsights button (looks like two circles next to the eyeball)
6. Click on the "Start Checking" button (see below)
7. The tracker will measure the Front Sight position, then switch to the Back sight position and report the error (it will also return to Front Sight)
8. It is recommended that backsights be checked at least one high or one low shot

9. If the error exceeds the tolerance, a Quick Volumetric Compensation must be done

QVC Overview (Full QVC)

The Quick Volumetric Compensation (QVC) uses a four-position test method. Laser Tracker3angular measurements are taken at four fixed positions (A, B, C and D). The API Tracker Software automatically



calculates six system error parameters and applies the appropriate compensation. The Full QVC should be run if the One-Point QVC gives a result greater than 0.004 degrees in elevation or azimuth.

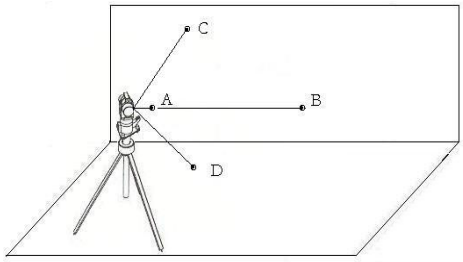
Equipment Recommended for QVC

- Laser Tracker II$^{PLUS!}$
- Tracker Stand
- API Calibration Tripod or SMR Drift Nest (Quantity 5)

QVC Setup

Turn off the servo motors (yellow switch on the front of the controller box). When the laser beam no longer points at an SMR the Tracker software will automatically display the Azimuth and Elevation angles.
Steer the beam manually to the position on a rigid wall (or other structure) where the nests will be glued. Make sure the Elevation angle reads within tolerance according to table 4 above.

1. **Position A** – Place the SMR and nest on the wall approximately 0.5meters from the tracker. Slide the nest up or down to locate the SMR at 0°. Mark the wall with the position of the nest. Hot glue the SMR nest to the wall.



2. **Position B** – Place the SMR and nest on the wall approximately 5 to 20 meters from the tracker. Slide the nest up or down to locate the SMR at 0°. Hot glue the SMR nest to the wall.

3. **Position C** – Place the SMR and nest on the wall approximately 0.6 to 1 meters from the tracker. Slide the nest up or down to locate **the SMR** (not the nest) at +55°. Mark the wall with the position of the nest. Hot glue the SMR nest to the wall.

4. **Position D** – Place the SMR and nest on the wall **or floor** approximately 0.6 to 1 meters from the tracker. Slide the nest to locate **the SMR** (not the nest) at -55°. Hot glue the SMR nest.

Point	Position
A	1. Mount SMR nest on wall at 0° ± 0.5° 2. Distance from tracker: approximately 1 meter
B	1. Mount SMR nest on wall at 0° ± 0.5° 2. Distance from tracker: 5 to 20 meters
C	1. Mount SMR nest on wall at (+)55° ± 5° 2. Distance from trackera: 0.6 to 1 meters
D	1. Mount SMR nest on wall or floor at (–)55° ± 5° 2. Distance from tracker: 0.6 to 1 meters

NOTE: *If practical, leave the SMR nests hot glued to the wall to run the QVC procedure in the future.*

QVC Procedure

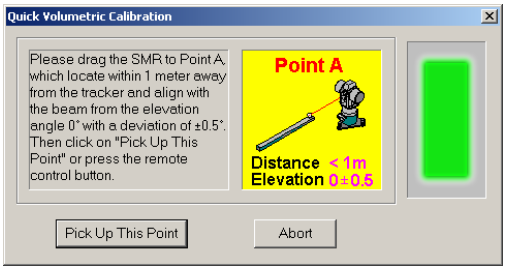
To start the QVC procedure, go to the **Calibration** menu and select **Quick Volumetric Compensation.** The QVC procedure will automatically step you through the measurement sequence.

Click– **Start Calibration**

Position A

5. Position the SMR on Point A, level with the tracker (0°) and about 1 to 2 meters way.

6. The graphical arrow on the right side of the window will prompt you to move the SMR in the indicated direction. When the SMR is in the correct position, a green box will replace the arrow to indicate proper positioning.



7. Click – **Pick Up This Point**

8. You will observe the tracker taking measurements in Frontsight and Backsight positions.

Position B

9. Position the SMR on Point B (0°), 5 to 20 meters from the tracker.

10. Click – **Pick Up This Point**

Position C

11. Position the SMR on Point C, any distance from the tracker at an angle between 50 and 60 degrees.

12. Click – **Pick Up This Point**

Position D

13. Position the SMR on Point D, any distance from the tracker at an angle between 50 and 60 degrees.

14. Click – **Pick Up This Point**

Saving QVC Data

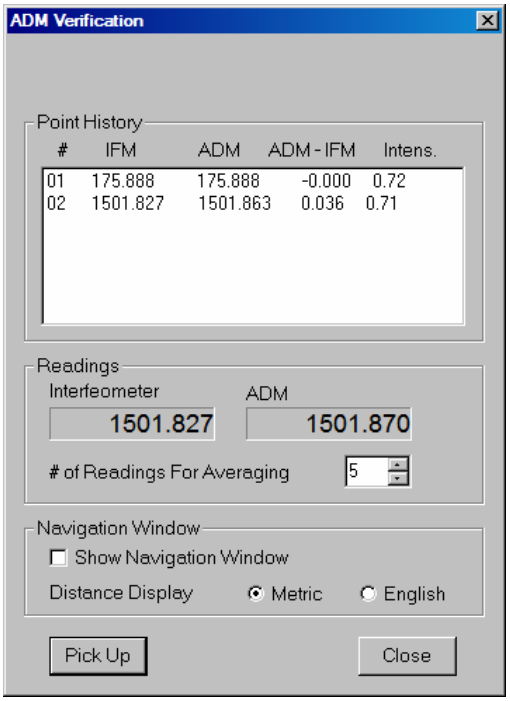
The software will prompt you to apply the new QVC data.

Click "Apply" to save the results. Click on "Don't Apply" to cancel without applying any results.

ADM Verification (ADM Models Only)

The ADM Verification tool directly compares the interferometer laser (IFM) with the ADM system. To use this go to the **Calibration** menu and select **ADM Verification**.

Note: The system will automatically go to the home position before a reading can be taken.
Click the button labeled **Pick Up** to take a reading. The results are displayed in the dialog box.



IMPORTANT NOTE: *An ADM Verification should be performed at the start of any new measurement job.*

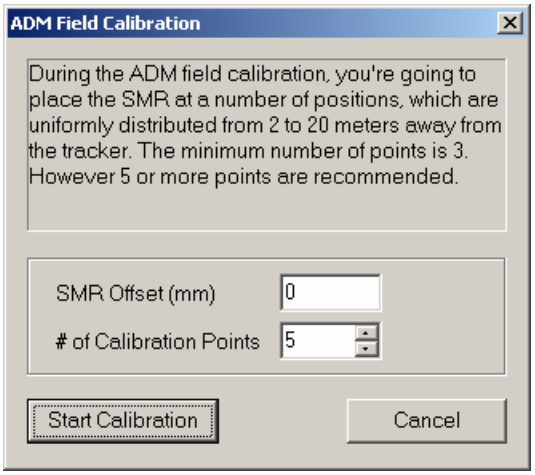
SOFTWARE TIP: *Check the Calibration Settings for the appropriate ADM setting (Stationary/Real-Time). Realtime evaluates ADM and IFM readings at the same time (best for a target that may have movment or slight vibration).*

ADM Calibration Overview

The ADM Calibration uses a multiple-position test method. ADM distance measurements are taken with the Laser Tracker3at a user defined number of fixed positions (3 or more). The default number of positions is 5. The API Tracker Software automatically compares the uncompensated ADM distances with the corresponding intereferometer distances and applies the appropriate compensation.

ADM Calibration Procedure

To start the ADM Calibration procedure, either click on the ADM Calibration button in the toolbar or go to the **View** menu and select **ADM Calibration.** The procedure will automatically step you through the measurement sequence.



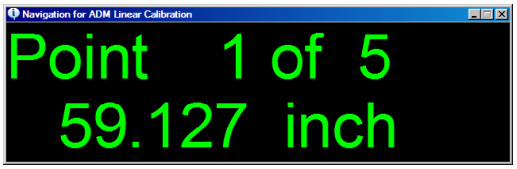
SMR Offset for ADM Calibration Dialog

☛ **IMPORTANT NOTE:** Enter "0" for Hollow SMR and enter "6.6" for Solid SMR.

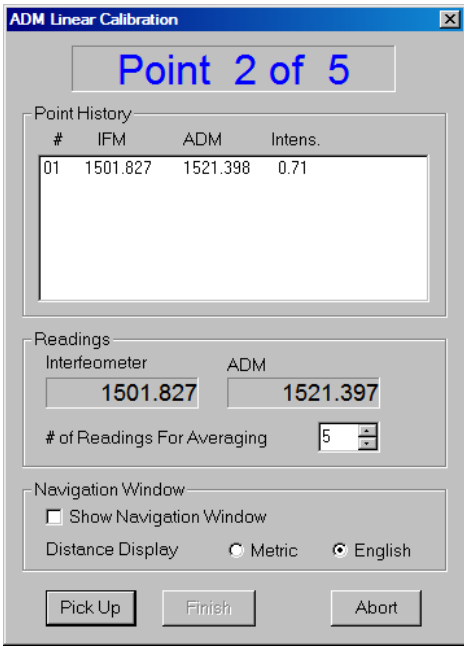
Because the ADM function is basted on a time-of-flight technique, passing through a solid corner SMR requires a constant to be used as an offset. The Constant for an API solid corner SMR (pictured in the dialog box and in Figure 7) is **6.6**. A hollow corner SMR requires no offset. Select "Start Calibration" to begin or "Abort to cancel.

The default number of calibration points is 5, which should very effective for most applications. This value can be raised or lowered (3 being the minimum) depending on the size of the measurement job and the accuracy required.

When the ADM Linear Calibration dialog appears, the "Navigation Window" option is enabled by default. This large window can be re-sized so that the user can see the distance prompt even when they are far away from the computer. Checking the "Show Navigation Window" will turn this feature on and off.



1. Place the target at point 1, which should be roughly three meters from the tracker at any angle. Regardless of the total number of calibration points selected in step 2, the first point should always be taken at 3 meters or greater. Alternately, you can fix a point and move the tracker a similar distance to get the same result. Click on "Pick Up This Point" to continue or "Abort" to cancel without applying any



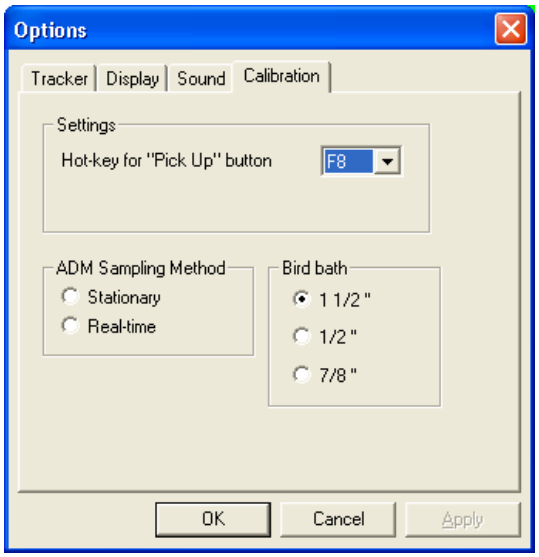
results. The tracker will take a single reading of the point, and not multiple backsights as in the QVC.

2. Move the target (or tracker) for each remaining calibration point. The points should be spaced at equal intervals with the final point being roughly 20% further than the distance to your work area. For example, if the object you are measuring is 15 meters away, and you used the default 5 points, a good scheme would be to take points at 3m, 7m, 11m, 15m, 19m.

3. After all points have been collected, the SMR must be returned to the Birdbath (initial position). The software will prompt you to do so. Note: if you choose to click the "abort" button at this time, the ADM linear calibration will not complete and the compensation will not be applied.

4. The calibration has finished. Click "Apply To ALL" to save the results (or "Apply To Current to save only in the tracker calibration software directory). Click on "Don't Apply" to cancel without applying any results.

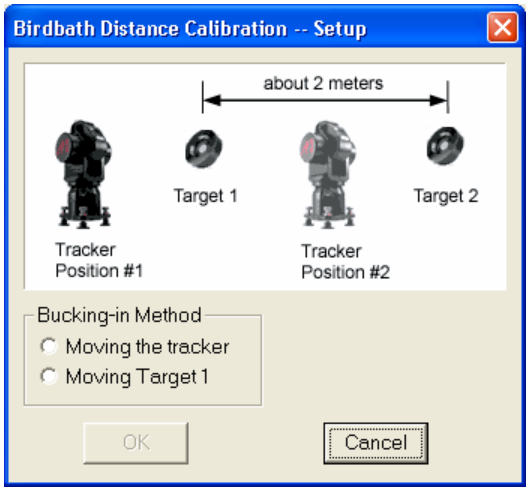
Birdbath Calibration Overview



Birdbath calibration is the name given to the procedure for setting the "reset distance" of the tracker's built-in home position, or "Birdbath." Since this home position is a permanent fixture of the tracker itself, it is expected that the user will not have great need to perform this operation frequently if at all. It is provided as an advanced feature.

The API Tracker3 has 3 permanent birdbath positions for different diameter SMRs (1.5 inch, 0.5 inch, and 7/8 inch). You can select which SMR position you would like to calibrate in the Options/Calibration menu.

The procedure for correcting birdbath error requires the user to measure two points at a distance about two meters apart. These points must be measured once from a position outside of the two points and again from a position between the two points (one point on either side). This can be accomplished either by keeping the points stationary and placing the tracker in two different positions, or by keeping the tracker stationary and moving the two points. It is up to the user to determine which method is most suitable.



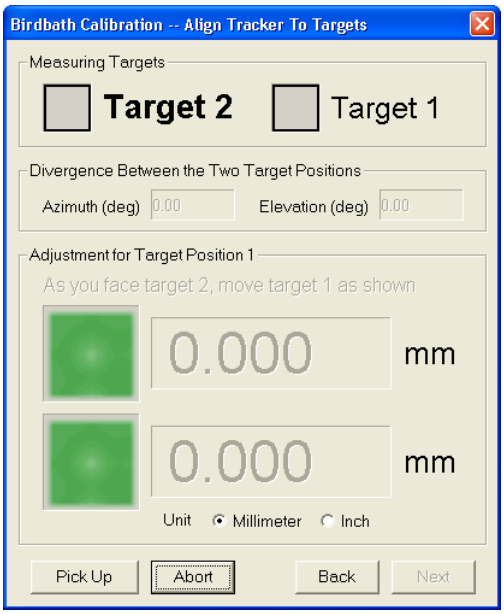
Birdbath Calibration Procedure

To start the Birdbath Calibration procedure, select Birdbath Calibration under the Calibration Menu. The Birdbath Distance Calibration Dialog will appear. Click on the "Start" button to begin the calibration. The Birdbath Distance Calibration Setup dialog will appear

and prompt the user to select a method: move tracker or move target.

Moving the Tracker (method)

1. The Set Targets dialog appears directing the user to do the following:
    a. Turn off the servo switch.
    b. Steer the beam to elevation = 0 and set/verify Target 2 at this elevation.
    c. Steer beam to elevation = 0 and set/verify Target 1 at this elevation.
    d. Turn the servo switch back on.
2. Click the "OK" button and the tracker will return to the home position. The Align Tracker to Targets dialog will launch.
3. Move the SMR to Target 2 and click on the "Pick Up" button.
4. Repeat step 3 for Target 1.
5. Observe the "Adjustments for Target Position" area in the lower half of the dialog window. If the dialog window shows "Within Tolerance," and green squares show in the adjustments area, then skip to step 6. If one or more red arrows are showing in the adjustments area, move the tracker in the direction indicated by the arrow, while facing target 2, by the amount shown, then click "Start Over." Repeat steps 3-5 until the "Within Tolerance" message is shown and green squares are showing in the adjustments area. Click "Next"



IMPORTANT NOTE: *from step 5 on, the targets should NOT be moved.*

6. Now that both targets are within tolerance, move the SMR to Target 2 and click the "Pick Up" button.
7. Move the SMR to Target 1 and click the "Pick Up" button.
8. Repeat steps 6-7 twice as prompted.
9. If the three sets of measurements are within tolerance, the "RMS Error" reading will turn green, and the "Next" button will be enabled. Click on the "Next" button. If the measured distances are not within tolerance, the "RMS Error" reading will turn red. Click on the "Start Over" button and repeat steps 6-9 until the measurements are within tolerance.
10. Turn off the servo motors and move the tracker to the second position (between the two points). DO NOT MOVE THE POINTS. Turn the servo motors on when the tracker is set at position 2.
11. Repeat measurements similar to steps 3-9. Click "Next" to continue.
12. When the measurements are completed, the Birdbath Calibration Dialog will reappear with a parameter file list and three buttons. The box under "Calibration" labeled "(Outside-Inside)/2" will show the Birdbath error. Click on "Apply to All" to adjust the Birdbath distance by the amount shown. A dialog box should appear, with a message that the parameter file has been changed. Click "OK"
13. After Homing the tracker, click on "Verify Distance" to begin the verification procedure. Make sure "Enforce the targets position check" is not selected. Without moving the tracker or targets, repeat steps 6-9 as prompted. (If "Enforce the targets position check" is selected, repeat steps 3-9 as prompted. This should be used only if the tracker was moved before the verification procedure.) When the measurement is complete, the Birdbath Calibration Distance Dialog will reappear. The box under "Verification" labeled "(Outside-Inside)/2" will show the difference found during verification. If this value is within ±0.005, then the calibration was successful.

Moving the Points (method)

1. The Set Targets dialog appears directing the user to do the following:
    a. Turn off the servo switch.
    b. Steer the beam to elevation = 0 and set/verify Target 2 at this elevation.
2. Click the "OK" button and the tracker will return to the home position. The Align Tracker to Targets dialog will launch.
3. Move the SMR to Target 2 and click "Pick Up."
4. Move the SMR to Target 1 and click "Pick Up." Observe the "Adjustments for Target Position area. Observe the "Adjustments for Target Position" area in the lower half of the dialog window. If the dialog window shows "Within Tolerance," and green squares show in the adjustments area, then skip to step 6. If one or more red numbers are showing in the adjustments area, rotate the targets by the angle indicated, while facing target 2, then click "Start Over." Repeat steps 3-5 until the "Within Tolerance" message is shown and green squares are showing in the adjustments area. Click "Next"

5. Follow steps 5-11 in the "Moving The Tracker" procedure above to complete the calibration.

ADM Maximum Intensity Search

☛ **IMPORTANT NOTE:** *the ADM Maximum Intensity Search is meant to be used ONLY in the event of a total loss of ADM intensity at a distance less than 10 meters. DO NOT use ADM Maximum Intensity Search unless directed to do so by an API representative.*

The ADM Maximum Intensity Search is a procedure used to temporarily correct physical mis-alignment of the ADM/IFM laser beams until such time as the alignment can be re-set by an official API technician. Because this procedure cannot be reversed without manual editing of the tracker's parameter file it should not be used unless you have been instructed to do so by an API representative.

To start the procedure, click "Troubleshooting from the main menu and select "ADM Maximum Intensity Search." The Dialog will prompt you to take the SMR at least nine meters from the tracker. Once at the proper position, click the button to pick up the point. You are then prompted to save the new ADM offset value in the parameter file.

Once the value is applied, the tracker will noticeably move its position when switching between an IFM measurement and an ADM measurement. This is due to the offset being applied and is normal. To remove the offset, either restore a previous PRM file or contact an API service representive for instructions on how to edit your PRM file manually.

Log File

Results of each QVC and ADM Linear Calibration as well as ADM Verifications are stored in the a log file located in the TrackerCal3 directory (default: **C:\Program Files\API Tracker Calibration v1.0.0.9**). Time and date information for each procedure is also recorded. To examine this file, open it with text editing software such as MS Notepad or MS Wordpad. The Log file will have the same name as the PRM file, but with a .log extension instead of .prm.

Advanced Topic - Parameter File (PRM)

The PRM file contains all of the factory settings your Laser Tracker, as well as the most recent in-field adjustment data (QVC, ADM Linear, etc.). This file is stored on the tracker controller and downloaded to the computer each time you start the TrackerCal3 software. Please note that the instrument can only be operated successfully using a computer that contains the PRM file (or a copy thereof). Each PRM file has a name corresponding to the instrument's serial number (usually in the form "3xxx.PRM").

The PRM file is updated each time an in-field adjustment is performed. For this reason, a backup copy of the original PRM file is provided on the API software CD that is included with your instrument. Under normal working conditions, the PRM file will be downloaded from the controller, edited by TrackerCal3 and uploaded to the controller without any concern from the user. However, if a problem should occur during the upload or download of the PRM file, or if the file becomes corrupt for any reason a backup copy of the factory calibration will be restored automatically in the controller. If this should happen, an notification will appear in the software. The user should then perform the in-field adjustments (One Point QVC and ADM compensation). For more information, or if you are having problems with your instrument please contact API directly.