

LASER RADAR

User Manual



API



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Laser Radar Quick User Manual Version 1.0

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WARNING:

API Laser radar uses diode lasers. Its system is classified as Class II.

DO NOT STARE INTO BEAM.

Failure to comply with this Warning may result in permanent eye damage.

Proprietary Data

All the data in this manual is proprietary and may not be disclosed, used, or duplicated, for procurement or manufacturing purposes, without prior written permission from Automated Precision, Inc.



Warranty

AUTOMATED PRECISION, INC. products are warranted against defects in material and workmanship for a period of two years from date of purchase. During this warranty period, AUTOMATED PRECISION, INC. will, at its option, either repair or replace products which prove to be defective.

Products must have prior AUTOMATED PRECISION, INC. return authorization, be returned transportation prepaid and properly packed. AUTOMATED PRECISION, INC. will pay ground shipping charges to return the product to the purchaser if defect is, in fact, covered under this warranty. For systems sold to customers outside the United States airfreight charges will be paid by Automated Precision, Inc. to return the product to the purchaser if defect is, in fact, covered under this warranty.

This warranty does not cover defects or damage caused by misuse, accident, negligence, alteration, misapplication, or repair by anyone other than AUTOMATED PRECISION, INC., and extends only to the original purchaser.

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1. Introduction

This technical user guide contains general and detailed information on the installation and basic operation for the Laser Radar. For advanced operation, please refer other documents and video provided by the Product Management Team in API. For maintenance, API R&D department is responsible for any issue and maintenance. Please contact the Product Management Team in API for scheduling any repair or maintenance.





2. System Set-up

Open the Laser Radar case; you should find the Laser Radar gimbal and some accessories in the case. Also included is a 1.5-inch spheres, a cable bundle for DC power and ethernet communication, Power adapter, an API-branded flash drive contains the necessary calibration software and parameters.



Setup the Laser Radar gimbal on the supplied LR stand making sure that the LR gimbal is secure on the stand. Tighten all the knobs of the stand prior to doing any measurements with the equipment. Connect all necessary cables before powering the LR system and utilize the UPS (Power surge protector if supplied with the system) to avoid any damage on the equipment in case power surge occurs. Should you need a step-by-step instruction, please refer our getting-started video (link) for detail instruction.

Laser Radar Kit - Included

 LR Gimbal	 Laser Radar Gimbal Stand	 1.5" Spheres (x2)	 UPS
 Invar Scale Bar 800mm (w/ case)	 API MeasurePro SW	 Calibration Tripod	 Bubble Level
 LR Communication Cable	 Dust Cover	 Laptop	 USB

Power up the Laser Radar System. After system is powered on the equipment it is ready to measure/scan. For optimum performance of the equipment please allow 30 minutes to warmup the system.

Start up the laptop provided with the LR system. If not provided with a laptop, follow the instructions below on how to configure your laptop.

Laptop technical requirements:

- Windows 10
- NVIDIA GeForce RTX 8GB
- 16GB RAM
- 512GB Hard Drive or greater

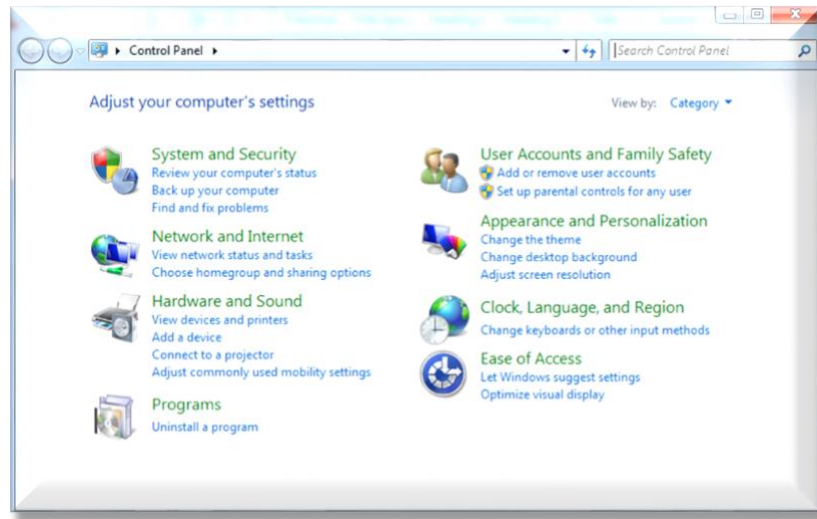
Computer Setup:

Step 1:

- Turn on the Computer. Make sure you have administrator privileges before you proceed with this procedure.

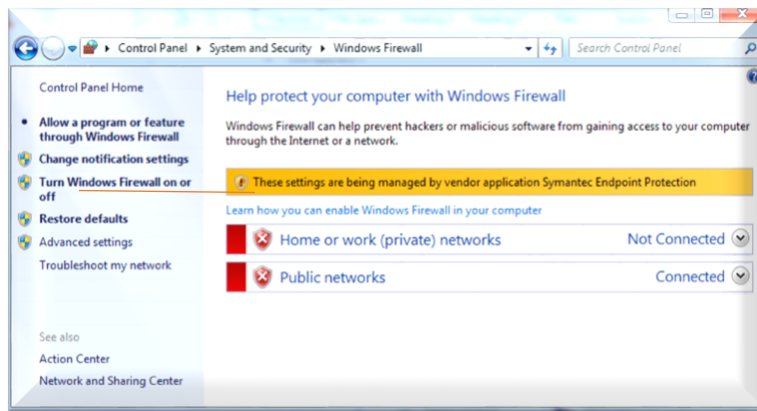
Step 2:

- Navigate to the **Control Panel** settings as shown below. Please note that it is shown in Category view style.



Step 3:

- Go to **System and Security** > **Windows Firewall** > On the left side of the window you will find **"Turn Windows Firewall On or Off"**. Set it to Disable all firewall. See image below. (Please contact your IT personnel if you are unable to make any changes)



Step 4:

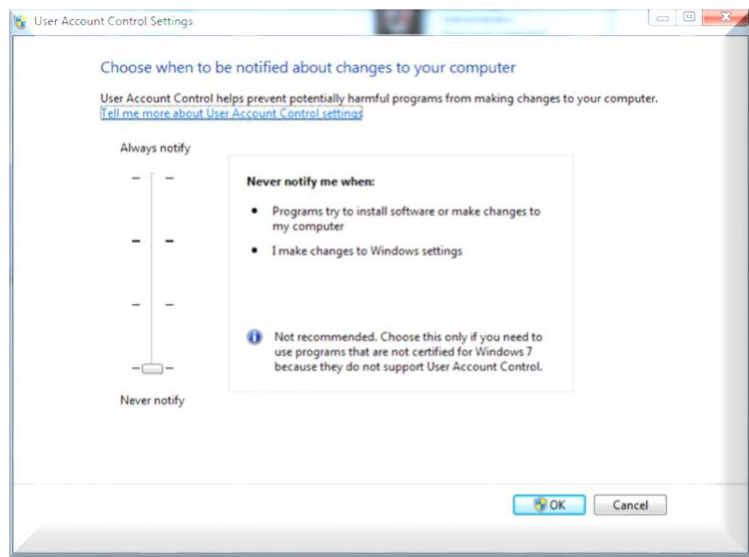
- Go back to Control Panel home then go to **"User Accounts and Family Safety"** go to **"User Accounts"** on the bottom of the window you will find **"Change user account control settings"**. See image

below. (Please contact your IT personnel if you are unable to make any changes)



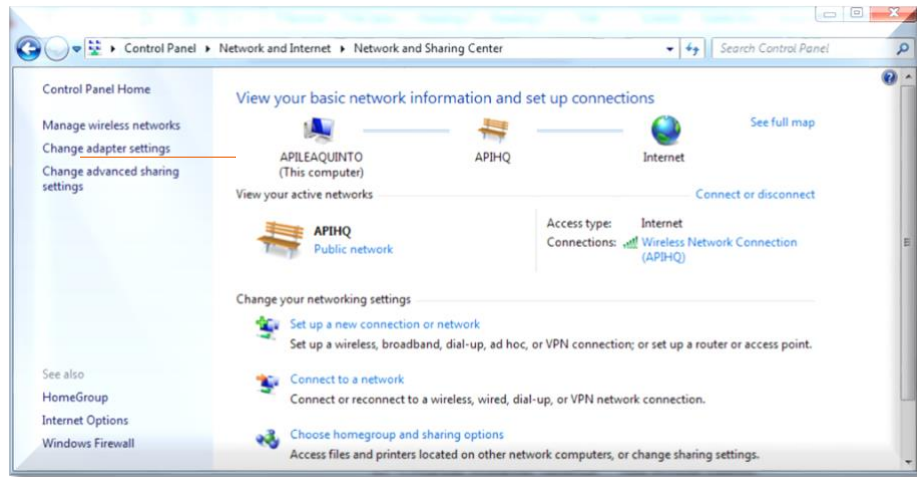
Step 5:

- Set the User account control settings to "Never Notify". See image below.

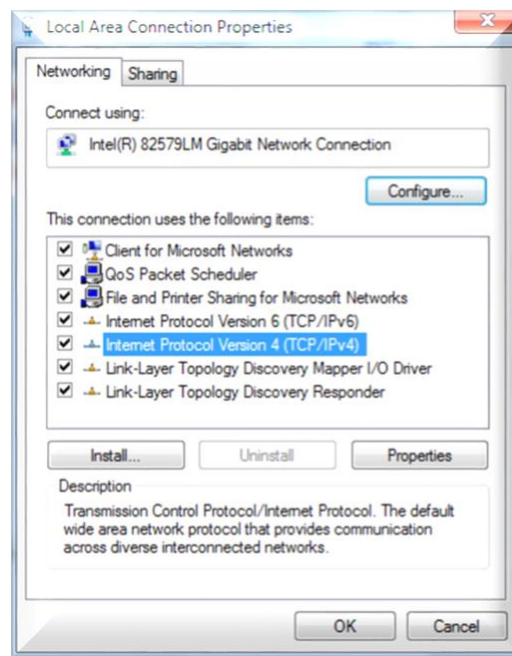


Step 6:

- Go back to Control Panel home then go to "Network and Internet" > "Network and Sharing Center" on the left side of the window go to "Change Adapter Settings". See image below.



- Go to "Local Area Connection" then highlight IPv4 as shown below and click on properties.



- Please select "Use the following IP address" as shown below and use the corresponding IP address and Subnet mask settings as shown in the images then click "Ok".
 - IP address 192.168.0.123



- Subnet mask 255.255.255.0

Step 7:

- If you have any third-party anti-virus software (Norton, McAfee etc.) residing in your computer or your internal network where your computer is connected to please ask your IT personnel to assist you on disabling this as well.

Step 8:

- Please note that restarting your computer might default to the original configuration of your computer before these changes has been done. So, I suggest checking the computer settings once again and make sure that the changes were applied to the computer after restarting your computer.

If the equipment has been provided with a computer, all necessary software has already been installed. To install the API MeasurePro software to a different computer, use the provided USB drive with the system, inside the software there will be an API Measure installer. Install it with admin privileges.

3. System Operation

About PRM file

There are three PRM (“parameter”) files in the system in json file format. These are created to set all necessary parameters to optimize the system including system calibration. You do not need to access or transfer anything unlike current API laser tracker system.

Index Search

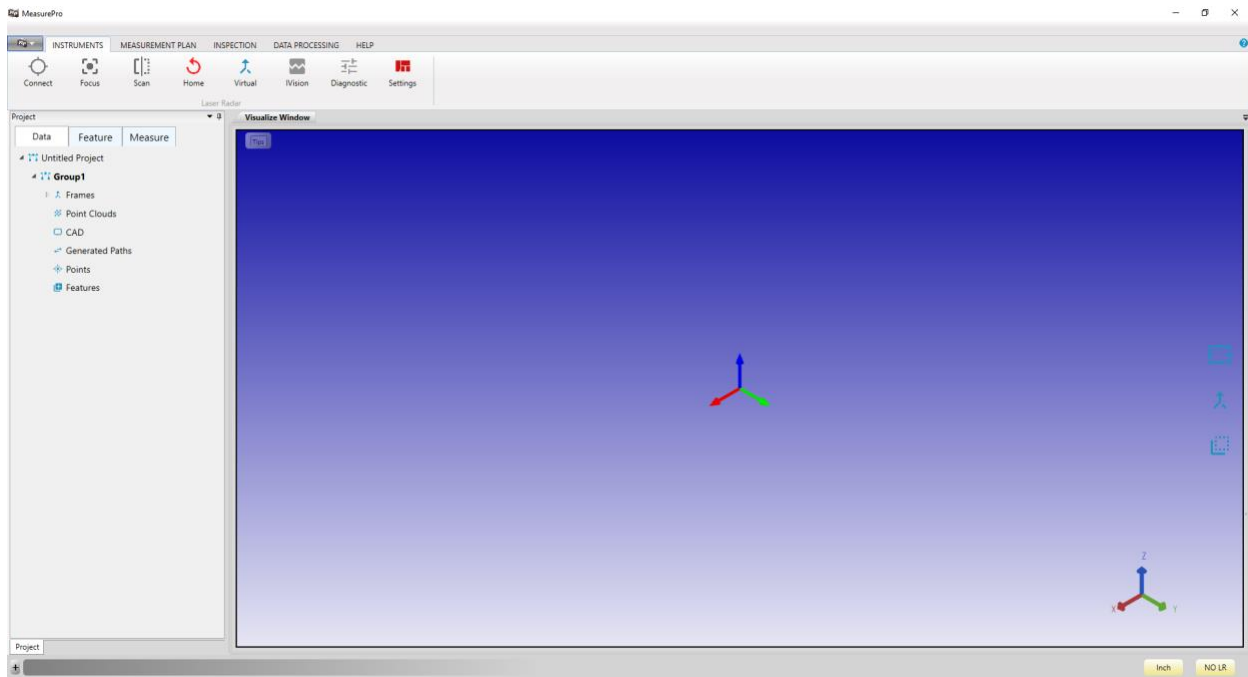
As soon as the unit is turned on, the red LED on gimbal head will flash. This indicates that the system firmware is booting. Please give it a few minutes to complete the booting procedure. Upon completion, it will automatically start the procedure of the



encoder index search of the gimbal elevation and azimuthal axes. As soon as it completes, you are now ready to open the MeasurePro software and connect it to the gimbal. Please make sure that the ethernet connection and the proper network setting (refer 'computer setup') were made.

UI tools

The current MeasurePro version was designed to interact using an optical mouse rather than a touch screen or a touchpad. Please make a keyboard and a mouse available for your best user interface experience.



iVision UI tool

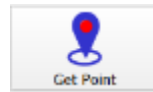
The iVision UI tool allows you to maneuver the gimbal and setup your measurement interactively through the camera vision. In most cases, the primary objective of using the iVision is to create reference points and scan path via video images provided by iVision. All the points and scan paths created by the iVision will be visible and available for scanning in the MeasurePro project tree. Find the tool button associated with the iVision on the main toolbar in the operation tab. Once opened, you can close it anytime. It won't affect to the gimbal operation or your setup.



'Set Point': It allows to aim and focus on a known coordinate. If you have recorded coordinates or known coordinates from CAD (pre-aligned to the laser radar frame), you can use this function to set it on the surface of the feature.



'Get Point': It acquires a single point from the given aiming direction. If it is not in off-focus condition, it will collect an averaged single point as a reference point. Otherwise, it will search the focus condition prior to the collection.



'Auto Focus': It searches its best focus condition along the given aiming direction. After the Auto Focus procedure completes, it is ready to setup a path for scanning and collecting points for point cloud.



'Auto Exposure' : It forces to set the camera exposure condition for optimum brightness. If you feel that the current brightness is not optimum, you may use this button to force to reset it.



'Home': It will move to the Bird-Bath position for the homing procedure. It will automatically return back to the previous position after the procedure completes.



'Flash Light On': It turns on the flashlight for increasing brightness of the iVision video. You may unlatch the button to turn it off. Otherwise, it turns off automatically after 2 minutes.



'Gimbal Control': You can latch this button and move your pointer by pressing down the left mouse button and drag toward the target position. This will allow you to maneuver the gimbal head for aiming to specific points that you want to direct. You may unlatch to turn off the control.



'Edge': It is a real-time image processing tool to visualize the edge features from images. The edge graphics will be overlaid on the video to highlight the edges.



'Contrast Target': It is a target feature recognition from a contrast target. It searches the 'check' pattern and highlight the boundary in real-time on video. Once selecting one of the target, the pointing beam will point to the center of the contrast target and be ready for scanning.



'Tool Ball': It is a tool ball target recognition. It allows to highlight balls on video streaming. Once selecting one, the pointing beam will focus on the center of the ball and allow to set up the tool ball scan.



'Take Image': It takes a panoramic image and place on panorama view window. You may open the view to see how it is updated. Taking additional shots at different aiming

orientations will allow you to stitch the image together with previous images. This is used for your customized panorama image setup.



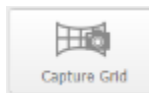
'Set Upper Left': It sets the current angular position as the upper left corner of the one diagonal end of the panoramic image



'Set Lower Right': It sets the current angular position as the lower right corner of the one diagonal end of the panoramic image



'Capture Grid': It is an automated image captures for creating panorama image. You need to set the two references prior to this by using 'Set Upper Left' and 'Set Lower Right'.



'View Pano...': It shows the stitched image at current process. You can update the image by using 'Take Image' button and adding additional images.



'Clear Pano': It clears the current panoramic image and allows to start from blank.



'Rectangle': It sets a box-shape scan path perimeter. Using your left mouse button down and dragging, you will be able to set a yellow box on the video.



'Polyline': It draws a polygon with reference points set by user. You need to position your mouse point and click the left button to set a point on the video to create a reference point. You need to move on and repeat for creating sequential points to draw a polygon. This allows to create an arbitrary boundary of the scan perimeter for customized scan.



'Cleanup Selection': It cleans up all the scan perimeters drawn on video.



'To Spherical'/'To Cartesian': It allows to switch the coordinate measurement display in the iVision between the spherical and the Cartesian coordinates.



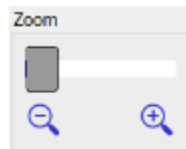
'Save Image': It takes a full resolution image at current orientation and allows to set a file name for saving a current image.



'Setting': It configures iVision's set parameters:



'Zoom': It is a digital zoom control up to 4x. Without zoom, it is 2MP resolution. At 4X, it becomes 8MP. You could control the zoom by rolling your optical mouse scroller.



QVC': it opens the semi-automatic calibration tool for 'Quick Volumetric Compensation'



General Operation with MeasurePro

The default unit is set in inch. To change, please lookup in the file menu and select 'Preference' to open a configuration window. The 'True Color for Point Clouds' are set as default, which means that it displays point clouds on the visualization window with corresponding RGB colors.

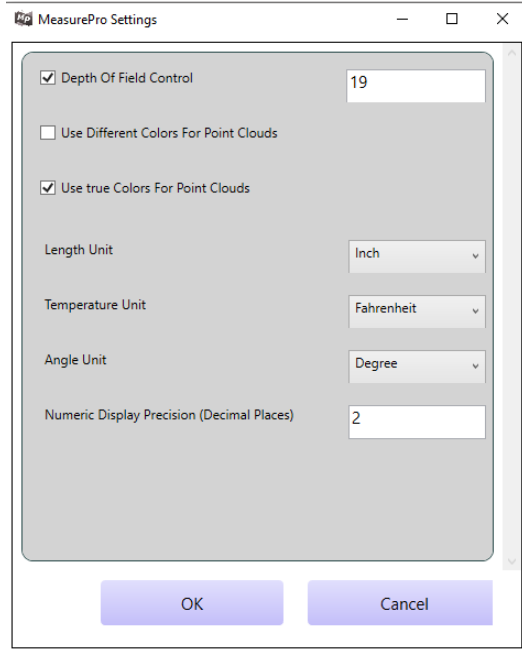


Fig. Preferences

To see system real-time parameters like temperature and pressure, open the diagnostic window by clicking the diagnostic tool button on the tool bar.

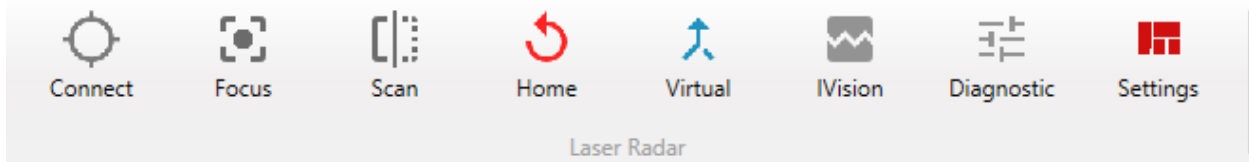


Fig. Tool bar image.

To start a measurement using the iVision UI tool, find the iVision open button on the tool bar of the MeasurePro main window.

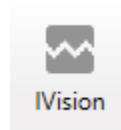


Fig. iVision tool button image

There are steps to create the scan path using the iVision.

- **Homing** : it is not a bad idea to start with 'home' for making sure any scale deviation is corrected prior to any measurements.

- **Gimbal Maneuvering** : Find your target by maneuvering the gimbal. You may latch the 'Gimbal Control' button and drag the mouse while pressing its left-button. You may use 'Ctrl' key(you need to hold down) instead of the 'Gimbal Control' button.
- **Searching Focus** : You need to make a best focus on your target before any measurement. You do not need to position the pointing beam accurately to the target center. At this moment, the LR just need to know distance close to the target. This allows you to set an optimum condition to start your measurement. Once completed, you will now be able to see coordinate information in real time.
- **Precision Positioning**: Use the left button of your mouse to pick a point from the live video for directing the LR to aim to the point. Repeat it until you are able to position the beam to the target. Use the 'Auto Focus'(or Shift + 's') to update precise focusing condition.
- **Perimeter Setting**: Use 'Rectangle' selection  or 'Polyline' selection  to draw a boundary of scan-path perimeter. Then, locate your mouse inside the boundary and click the right mouse button to select 'Generate Plane Scan Path'. It will pop up the configuration window. You can set the scan line spacing ('Resolution') and select either the vertical or the horizontal scan direction.

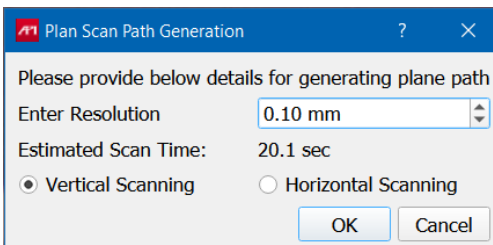
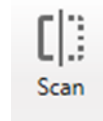


Fig. popup windows for scan path configuration.

- **Ready To Scan**: You now have a generated path that allows you to command area scan for your target measurement. You may close the iVision window or minimize it and maximize the MeasurePro main window. Please find the generated path on the list of the project tree. Select the path and click the scan button on the tool bar for executing the scan action.





4. Laser Radar Infield Calibration

API LR infield calibration is designed to provide quick and easy procedures for bring the system to factory-calibration condition. The infield calibrations include the scale Referencing and the quick volumetric check (QVC).

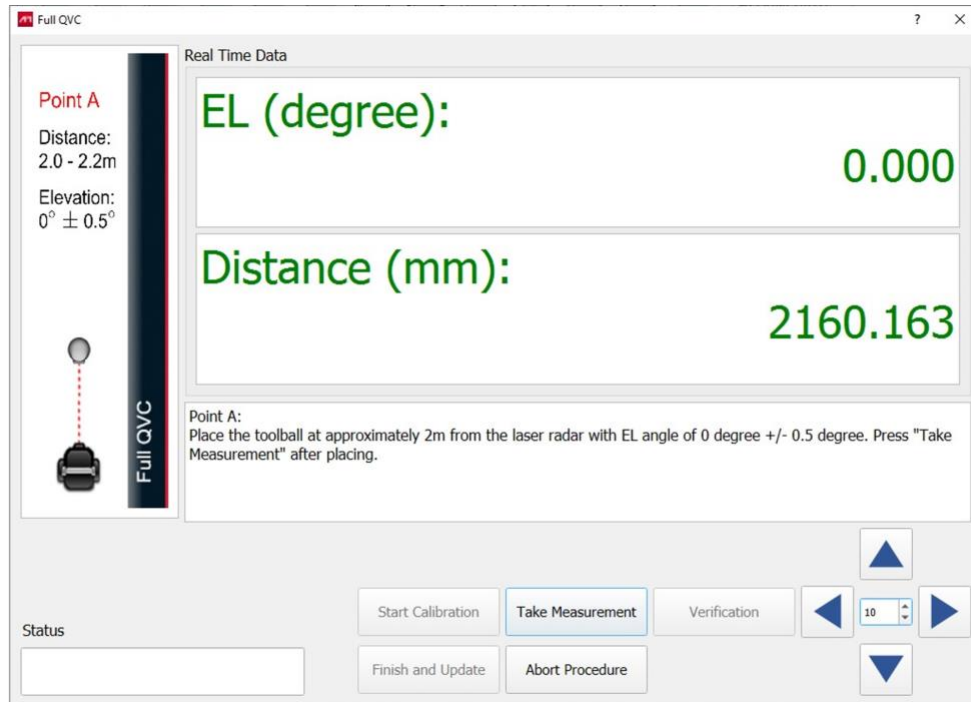
Scale Referencing

The Scale Referencing allows to readjust the ranging offset relative to the gimbal pivot location and the range scale. Since the LR gimbal body temperature is at least 5 degrees higher than the environmental air temperature, the offset and scale grow naturally while the system is warming up. API designed a nominal reference length on the gimbal body that can be referred anytime whenever the system or user requires to correct. To access this infield calibration, user just needs to command 'Home' by clicking 'Home' button either on the MeasurePro main tool bar or on the iVision tool bar.

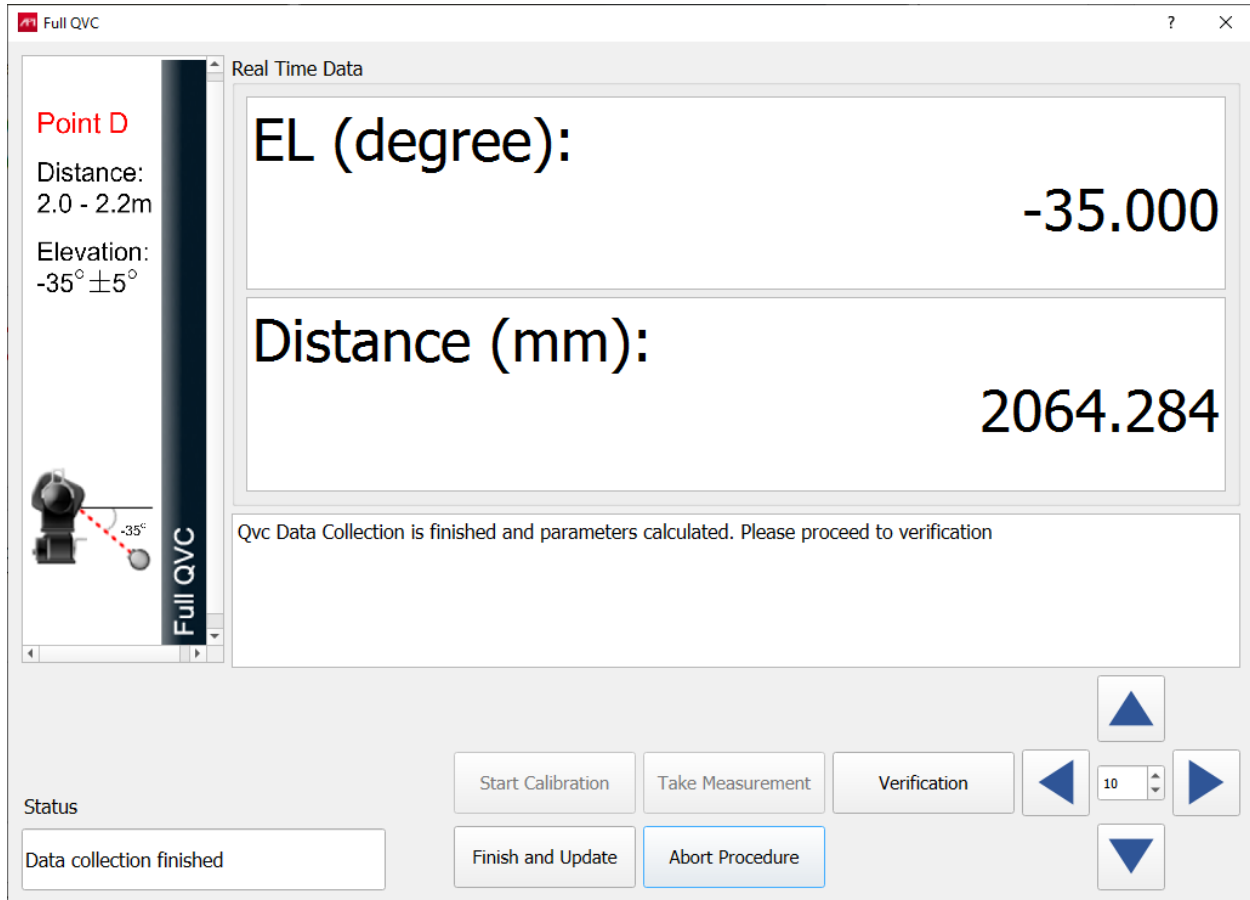
It will automatically refer by pointing the beam to the birdbath and correct the offset and the scale. If auto-returning option was selected, it will come back to the last position.

Quick Volumetric Compensation (QVC)

The 4-Point or "Full" QVC (Quick Volumetric Compensation) compensates all six geometric error parameters using four two-face measurements at specific locations within the LR volume. The four points are lettered; with Point A at a distance of less than 1 meter from the tracker, Point B at a distance of [greater than] 5 meters from the tracker, Point C at an elevation between 50 and 60 degrees, and Point D at an elevation between -50 and -60 degrees. At the completion of the 4-point QVC, the user will be notified if any of the error parameters exceed the recommended tolerances. Parameters that exceed the recommended tolerances may require manufacturer attention. In all circumstances (even those with parameters out of tolerance) the physical errors will be compensated by the model. It is recommended that the user perform two-face (frontsight/back sight) checks at various locations within the LR volume to ensure the validity of the compensation.



The four points are lettered; with Point A at a distance within 2m to 2.2m from the LR while the elevation angle (EL) is set to 0 degree, Point B at a distance within 4.9m to 5.1m from the LR at EL = 0, Point C within 2m to 2.2m at EL = 55 (+/- 5 degrees) degree, and Point D within 2m to 2.2m at EL = -35 degrees (+/- 5 degrees). Unlike the QVC in the API's Tracker Cal, the LR aims the beam to targeted EL and AZ angles and makes beam focus to the target distance. For example, for the point A, it aims at (EL, AZ, Distance) = (0 deg, 0 deg, 2.1m). It then monitors the return signal to detect the target to be placed to the point. If user places the center of a 1.5 inch ball to the aimed beam focus (It should allow +/- 2mm centering tolerance), the color of the coordinate display turns to green. Because the AZ is not a constrained, you may set it at user's preferred angle by jogging it using the jog tool buttons. For point C and D, user can adjust the EL angle by (+/- 5 degrees). Upon completion of the setup, user may proceed by clicking 'Take Measurement' button. The LR will automatically scan and fit the ball for the front and the back face modes. Once all four points measurements are completed, it will ask to proceed verification with the calibration results by clicking the 'Verification' button. Depending on the results that it reports, user may abort the procedure and repeat the QVC or update and finish.



The screenshot shows the 'Full QVC' software window. On the left, a vertical panel displays 'Point D' in red, 'Distance: 2.0 - 2.2m', 'Elevation: $-35^{\circ} \pm 5^{\circ}$ ', and a small diagram of the gimbal system. The main area is titled 'Real Time Data' and contains two large boxes: 'EL (degree): -35.000' and 'Distance (mm): 2064.284'. Below these, a message states: 'Qvc Data Collection is finished and parameters calculated. Please proceed to verification'. At the bottom, there is a 'Status' box showing 'Data collection finished', several control buttons ('Start Calibration', 'Take Measurement', 'Verification', 'Finish and Update', 'Abort Procedure'), and a set of navigation arrows with a '10' in the center.

IMPORTANT NOTE FOR BEST PRACTICE OF 4-POINT QVC

For convenient and quick QVC operation, we recommend building QVC monument nests and dedicated fixed LR stand as a QVC test fixturing cell. The MeasurePro allows to operate automatically the 4-points collections and update parameters. You do not need to perform the QVC again for local transporting the unit or repositioning. The gimbal system is robust enough to apply the same compensation parameters.

We recommend implementing this QVC after shipping or if your storage temperature varies over more than 18 degrees (in Fahrenheit).

IMPORTANT NOTE FOR BEST PRACTICE OF OPERATION

You may check on so called 'body temperature' by opening the diagnostic window (on tool bar buttons). At steady state (full warm-up), it usually has at least 27 degrees in Fahrenheit higher than the environmental air temperature. If it is colder, the gimbal is still warming up. You may apply 'homing' for scale correction with interval. Here are our suggestions in terms of the interval.



- Cold start (less than 9-degree difference): as often as possible
- 9 to 18-degree difference: every 10 min
- 18-degree to steady state: every 20 min
- Steady state: every hour

5. Laser Radar Storage

The LR25 should be stored in the supplied foam case when not in use. Avoid leaving the foam case in sunlight or extreme heat while in storage. Please make sure putting on the lens protection cover for dust and fingerprint protection.

The storage temperature ranges from -4 degree to 140 degree in Fahrenheit.

7. API Customer Support

Automated Precision Inc. is committed to providing superior support to its customers. To assist you with technical and application questions, API asks that customers use a following method to contact our help desk:

API World Headquarters

Automated Precision Inc.
Customer Support
15000 Johns Hopkins Drive
Rockville, Maryland 20850

Email: support@apimetrology.com

Telephone: Contact the API help desk at **(240) 268-0400** or toll free at **(800) 537-2720** between the hours of 8:30 AM and 6:00 PM EST.

Fax: Forward questions with a detailed description to **(301) 990-8648**. Please include a return telephone number that can be used to contact sender.

Regional Offices:

API Services

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API

NOTHING BEYOND MEASURE

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