



AUTOMATED PRECISION INCORPORATED

tracker3

LASER TRACKING SYSTEM USERS MANUAL

For Models LTS-3000
V. 1.0

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General Information

1 Model Numbers:

The Laser Tracker 3 System has the following model number:

- **LTS-1000** (Includes Interferometer and Turbo ADM modules)

The model number and serial number are printed on the nameplate on the backside of the tracker head unit near the attachment point for the Tracker/Controller cable (See Figure 1).

2 System Overview

The Laser Tracker 3 is a portable, high precision coordinate measurement system. The Laser Tracker 3 combines interferometer based laser optics with state-of-the-art servo control technology to measure the position of a target relative to the tracker. Tracker 3 also contains API's unique "TURBO ADM" system for enhanced flexibility. With the specialized software provided, the real-time positioning information can be used to measure relative distances between points, set up virtual axis, monitor the movement of a part, or compare real world production to a CAD model.

This system may be used for building and inspecting fixtures, inspecting large assemblies and parts, calibrating robots, and error mapping machine tools and CMMs. Other applications include measuring point-to-point structural dimensions or point deformations under load, part alignment, and large part surface scanning.

Interferometer (IFM)

For the Tracker 3 to measure, the laser beam is reflected from a retroreflective target (SMR). The laser tracker determines the coordinates of the reflector by measuring two angles, elevation (EL) and azimuth (AZ), and a radial distance. Angles EL and AZ are measured using encoders mounted on the azimuth and elevation axes of the laser tracker. The radial distance is measured using a device called an interferometer. An interferometer measures distance in terms of wavelength of light. The coordinate data is transferred to the host computer and application software. The software transforms this data into a user defined coordinate frame constructed from a system of datums.

 **Important Note:** *The distance measurement becomes invalid when the path of the laser beam is interrupted. This interruption, referred to as beam break, causes the distance measurement to be invalid until the reflector is measured to a known reference distance such as the birdbath (home position) or TURBO ADM.*

TURBO ADM (Absolute Distance Measurement)

In addition to the helium neon laser, the Laser Tracker 3 uses the TURBO ADM system for Absolute Distance Measurement. This system employs an infrared (non-visible) laser. When using the ADM function the user does not have to return the reflector to a known reference distance to reset the laser interferometer distance following a beam break. This allows measurements to be taken at points where it is impractical or simply not possible to move the SMR to the target without obstructing the laser path (i.e. having the laser shoot down a long section of conduit or pipe).

API's TURBO ADM system is based on an innovative repetitive time-of-flight technique (RTOF) offering fast response and superior accuracy while being fully integrated into the tracking head of the unit. The TURBO ADM gives the Laser Tracker 3 the ability to acquire the SMR immediately should the beam be interrupted. Using this method it is possible to acquire a SMR simply by holding the target in hand and moving it into the path of the visible laser beam. Note that due to the inevitable small movements of the human hand, re-acquiring a SMR in this manner may introduce error into measurements, a condition represented by a slowly flashing green indicator light on the tracker head unit. To establish a more accurate distance, the SMR can be held still against a stable object (such as the wall or floor). This will cause the indicator to turn from a slowly blinking green to a steady green. At this time the distance information measured by the ADM is used to reset the Interferometer and measurements continue in IFM mode.

For added flexibility in your measurement jobs, it is also possible to set the Tracker 3 in "ADM ONLY" mode. When using this feature, the ADM will not reset the interferometer but continue measurements using the RTOF method. Please consult the appropriate documentation for your application software for detailed information on how to change modes.

T3 Instrument Features

- Long range - work volume over 60meters radial or 120 meters diameter (400 feet!)
- Adaptive temperature control
- High speed TCP/IP communication
- Embedded electronic level
- Quicklink Tripod mount
- Enhanced TURBO ADM (8ms)
- Digital weather station
- Material temperature sensors
- Multi-birdbath for 1 1/2", 7/8" and 1/2" SMRs

NOTICE

Testing has established that a warm-up period of at least 30 minutes from a cold start-up is required to obtain published accuracy. If the tracker is stored in an environment different temperature than the work area, a longer warm-up period may be required.

The system is designed to operate over a voltage range of 100 to 263Vac. Using voltages other than specified may cause system damage and void the warranty. To ensure proper voltage, it is recommended to use the system with an Uninterruptible Power Supply (UPS).

3 Precautions and Special Hardware Considerations



Figure 1: Tracker Markings

WARNING

**The 3D Laser Tracker 3 employs a Class II visible laser beam.
AVOID LOOKING DIRECTLY INTO THE LASER BEAM.**

Also, the Laser Tracker 3 System uses an infrared laser and is classified as a Class I laser product. This laser is harmless to the human eye.

ELECTRICAL SAFETY WARNING

The unit is provided with a three-wire power cord. Connection to a protective earth is required at all times.

**UNDER NO CIRCUMSTANCES SHOULD THE EARTH WIRE BE
DISCONNECTED.**

Notice

Use of the equipment in a manner not specified in this manual may void the warranty and impair the protection provided by the equipment.

There are no user serviceable parts in the controller or on the tracker head. Do not attempt to perform any mechanical or electrical modifications, as this will void the warranty.

CAUTION

Disconnect all power before servicing equipment.

Equipment Markings	
Symbol	Description
	CAUTION: High Voltage If used improperly, this equipment carries the potential for injury from high voltage electric shock.
	Protective Earth (Ground) CAUTION – disconnection of the protective earth conductor inside the system may impede the protection afforded by the system.
	CAUTION If used improperly, this equipment can be dangerous. Exercise caution and operate in accordance with manufacturer's guidelines.
	CAUTION - Laser Radiation - Do Not Stare Into Beam. Class II Device in accordance with FDA - CDRH. Class II Laser is a visible laser beam (400nm to 740nm) that is considered eye safe. <i>Do not stare into the laser beam.</i>

Table 1—Equipment Markings

4 General Operating Specifications

The system is designed for continuous operation between 100 and 263 volts A/C. Connection to a protective earth is required. Using voltages other than specified may cause system damage and void the warranty. CAUTION – disconnection of the protective earth conductor inside the system may impede the protection afforded by the system. DO NOT plug/un-plug and any cables if the power is on.

There are no user serviceable parts or fuses in the controller or the tracker head. Do not attempt to perform any mechanical or electrical modifications, as this will void the warranty.

<u>Parameter</u>	<u>Specification</u>
Linear Range:	T3-15 30 meters (98 feet) T3-40 80 meters (262 feet) T3-60 120 meters (400 feet) With selected targets
Angular Range:	
Azimuth	± 320° (640° End to End)
Elevation	+ 77° / -60°
Angular Resolution:	± 0.07 arc seconds
Distance Resolution:	1µm
Maximum Lateral Target Speed:	> 3meters/sec
Maximum Acceleration:	> 2 g
Internal Level Accuracy:	±2 arc-second
<u>Weight</u>	
Tracker	18.5 lb
Controller	7 lb
<u>Interferometer Mode</u>	
Absolute Accuracy	
Static:	± 5ppm (2 sigma) 25µm (0.001") at 5m (16.2ft)
Dynamic:	± 10ppm (2 sigma) 50µm (0.002") at 5m (16.2ft)
<u>ADM Mode</u>	
Linear Accuracy	± 15µm to 10m 1.5ppm > 10m
<u>Dimensional Envelope</u>	
Tracker	185 mm x 190 mm x 360 mm
Control Box	110 mm x 160 mm x 310 mm
<u>Electrical</u>	
Input voltage range (110):	110 VAC +/- 10%
Input frequency range (110):	60Hz +/- 6%
Input voltage range (220):	220 VAC +/- 10%
Input frequency range (220):	50Hz +/- 6%
Amperage	4.0A Max
Maximum Power Usage	350W
Fuse Rating	4A (115V) / 2.5A (230V)
<u>Environmental</u>	
Air Temperature	-10°C - 40°C (14°F - 104°F)
Barometric Pressure	580 mmHg - 800 mmHg
Relative Humidity	10-92.5% Non-condensing
Altitude	2000 Meters

Installation

5 Equipment Supplied

This section gives a brief description of the various components that make up the Laser Tracker 3. Additional specialized fixtures may be required to assist in tracker head or target mounting depending on the specific application. Optional equipment and accessories are not listed here, but instead are given individual sections in this manual (See Table of Contents). The following is a list of the hardware included in the Laser Tracker 3 package (See Fig. 2):

Laser Tracker 3 Package	
Item	Description
1	Tracker Head
2	Controller
3	Cross-over Ethernet Cable
4	Tracker/Controller Cable
5	AC Power Cable (US only)*
6	Cable and Accessory Bag
7	Digital Environmental Sensor (Temperature and Pressure)
8	Dust Cover
9	SMR Cleaning Kit
10	TrackerCal v3 Software & Parameter File Backup Mini-CD – not pictured
Table 2–Package Contents	

* Supplied with units manufactured for use in the U.S. only. Any substitute power cord must be UL Listed and/or CSA Certified rated 300 Volts AC, 18 AWG, 75°C.



Figure2 - Equipment Supplied

Tracking Head

The tracking head is comprised of a single beam laser interferometer, and is contained in a dual axis servo-controlled housing. This unit is designed to track a target by active control of the pitch and yaw movement of the beam housing. The tracking mechanism is attached to a mounting base, which may be mounted on a tripod or to a flat surface using the optional Tri-mount Base. The indicator lights on the upper face of the tracker head contains two indication lights, one colored red (laser) and one green (tracking/lock). The following table (table 3) indicates the status of the lights.

Tracking Head Indicators	
Red Blinking (laser head warming status).	Laser is powered on but in the process of warming up.
Red Steady	Laser is powered on and ready to take measurements.
Green Steady (Tracking/Lock)	Tracker has established the distance to the SMR and is ready to give measurement data. If the beam is broken or obstructed during a measurement, the light will turn off to indicate that the SMR must be brought back to the home position or re-acquired through ADM.
Green Off	Beam interruption. Tracker has lost lock with SMR.
Green Blinking (Rapid)	Tracker is acquiring measurement data.

Table 3—Indicator Lights

SMR (Spherical Mounted Retroreflector)

The target is a precisely made SMR (**S**pherical **M**ounted **R**etroreflector) designed to return the beam back to the laser source. The tracker will follow the target as long as the incident angle of the beam on the target face does not deviate from perpendicular by more than 25°.

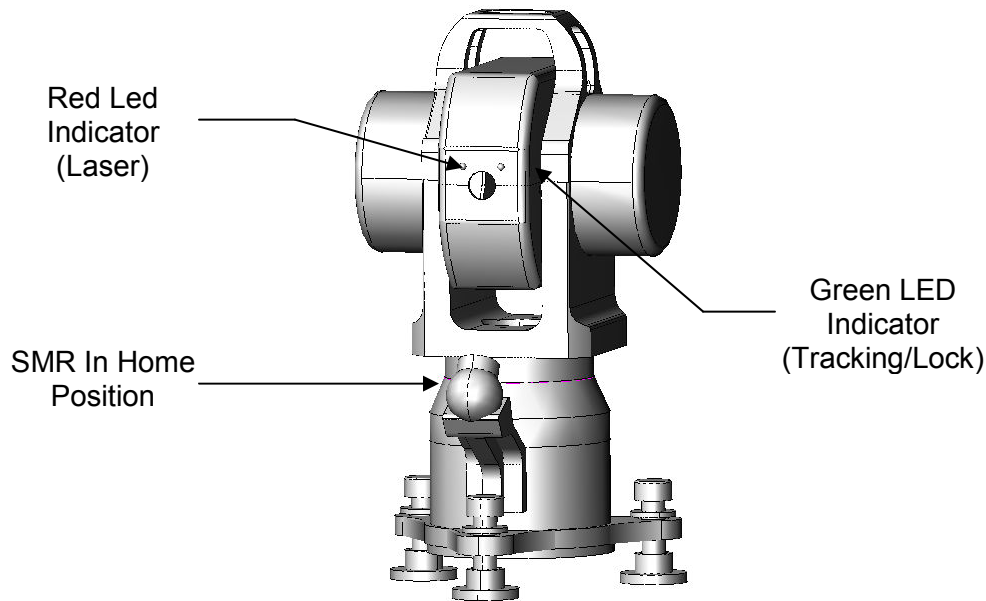


Figure 3—Indicator Lights and SMR Home Position

Controller

The controller houses the essential components that control the Laser Tracker 3. This includes systems to drive or handle feedback from the following hardware and sensors:

- Encoder positions of the tracker
- Shaft motors of the tracker
- Distance measurement of the interferometer
- Dual axis photo sensor for measuring azimuth and elevation displacement of the SMR
- Weather station data

The controller contains three switches: servo power, laser power and a controller reset switch power. The main power must be enabled before the servo power. Please

be aware that there are no user serviceable parts inside the controller. DO NOT attempt to adjust the settings of the components inside.

Instrument Setup

6 Setup Overview

The Tracker 3 system is extremely portable and offers several options for setup. The system comes standard with the API Quicklink tripod mount. This two-piece mount can be added to any instrument stand with a standard 3.5-inch diameter thread.

Alternately, the tracker may be fitted with the optional Tri-Mount base for mounting directly to a machine tool or other flat surface.

 **Note:** Please contact your local API representative for information on other optional mounting accessories such as right angle mounts, low profile tripods, etc.

7 Quicklink Tripod Mount

The Tracker 3 comes standard with the Quicklink Tripod mount installed. To mount the system to the tripod, fit the teeth of the tracker base into the grooves of the tripod platform. The system should hold firmly in place with no rotational movement possible. Finally, tighten the threaded ring until it is snug.



8 Hardware Connections and Installation

Before installation and connection of the components, verify that the controller power is OFF. Connection of components while the power is ON may damage the electrical hardware. DO NOT block the cooling fans on the back and bottom of the control box as this will lead to excessive heat build up that may damage the hardware. Refer to the following diagram for definitions of symbols found on the controller front and back panels (Figure3).

Perform the hardware installation and electrical connections according to the following procedures (refer to Figure 3 & 4, and Table 2 for cable descriptions):

1. Mount the tracking unit on a tripod or mount the tracker head using Quicklink mount. Note that the distance measurement is based on interferometry and if the beam is broken the target must be “Homed”. Therefore, certain beam obstructions must be considered when setting up the tracker prior to taking measurements. Consider your environment when placing the stand.
2. If the API Laser Tracker 3 electronic level is being utilized to create a level based frame, the laser tracker must be vertical to ± 2 degrees. To acquire vertical of the laser tracker the tripod feet are adjusted while using a level setup feature in the software.
3. Install the target, SMR, in the birdbath.
4. Place the controller in a convenient location so that there is some reasonable slack in the cables. Taught cables may constitute a tripping hazard.
5. Connect the tracker encoder/motor cable between the control box and the tracker unit. See Figures 4 for connection illustrations.
6. Connect the AC power cable between the control box and an AC outlet. Standard AC input voltage must range from 100V to 263 V.
7. Connect the Ethernet crossover cable between the control box and the PC or laptop.
8. Connect the digital temperature/pressure sensor to the controller. Be sure that the air temperature sensor (the silver cylindrical sensor) is hanging freely and not in contact with a thermal mass that may be warmer or cooler than the ambient temperature.
9. After electrical connection is complete, the main system power may be turned on followed by the power for the servo-system. See Figure 3 for switch locations.
10. If after use during a measurement session, the tracker system is scheduled to be idle for a long period of time before additional measurements are taken during the session, it is recommended that the servo system be turned OFF, but the main power be left ON.

Power (Laser) Switch & Indicator

Servo (Motor)
Switch &
Indicator

Reset Button
(hold for 3
seconds)



Tracker/Controller
Cable (Gimbal)

Environmental Sensor
(Weather Station)

Ventilation Fan
(Do Not Block)

Antenna (for
wireless
accessories)

Ethernet (LAN)
cable.

AC Power Cable
(U.S. Only)



RF Wireless
Accessory On/Off

Figure 4- Controller Ports and Markings



Figure 5- Tracker Connections

9 Software Considerations

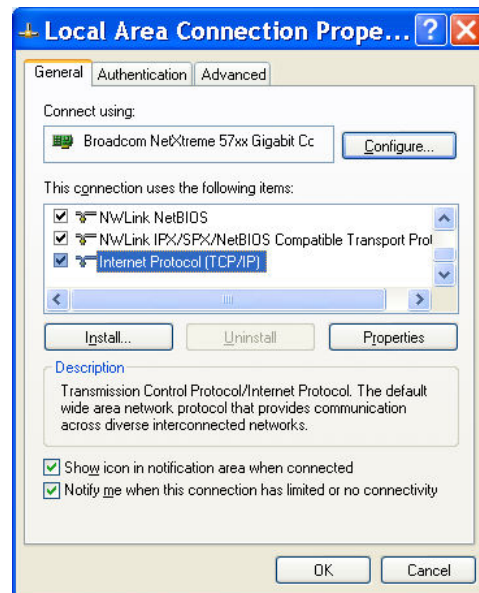
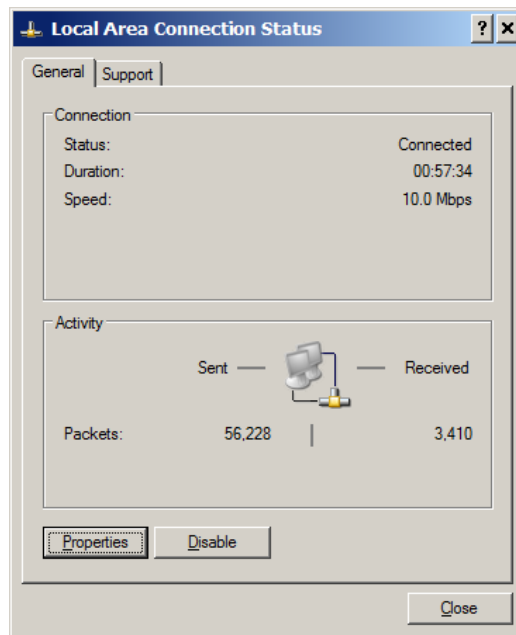
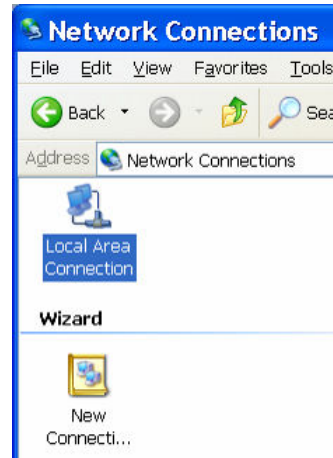
The Tracker 3 uses the TCP/IP standard to move information between the tracker controller and the host PC. For this reason, the host computer must have networking enabled and configured properly.



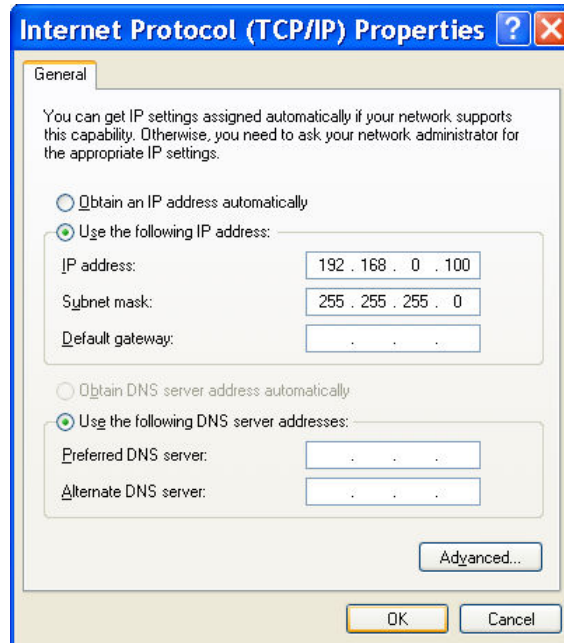
Important Note: *A computer supplied with your tracker will be pre-configured to work properly without further modification.*

The following procedure should only be necessary if you experience problems connecting to the tracker with TCP/IP.

1. Open the Networks setting from the windows control panel.
2. Double click the icon for your Ethernet controller (“local area connection” is usually the default).
3. Click on the button marked “Property”
4. On Tab “General”, Select the TCP/IP and then click “Property”



5. Check “Use the following IP address.” Use the following values:
 IP: 192.168.0.100
 Subnet Mask: 255.255.255.0



6. Click OK and then click the “close” on the dialog.

10 Setup Final Check

After the system is secured on the stand, it is good practice to check the following items to insure accurate measurements.



Important Note: *the following list assumes the use of an API brand folding tripod. If using a different stand, please the documentation provided from the stand’s manufacturer. Although every effort is made to insure similar performance in all circumstances, API cannot guarantee proper performance on mountings other than those manufactured by API.*

- Confirm that the legs of the tripod are opened fully and the outer ring has slid up to rest against the stop.
- Confirm all connections are tight:
 - Tripod feet (jam nut x3)
 - Outer ring (wing nut)
 - Inner tube locking screws (x2)
 - Quicklink
- Confirm the digital temperature sensor is not against a stationary mass, but is measuring the same air density where your measurements will be taken.

11 Traceability

The Laser Tracker 3 when calibrated and maintained properly will provide measured data that is traceable to the National Institute of Standards and Technology (NIST). Refer to the certificate sheet for components of the laser tracker system that are traceable to these standards.

Software and System Maintenance

12 Software Installation

The tracker is delivered with two software packages: API “TrackerCal” (for maintenance) and a geometric analysis package as appropriate for the user’s applications.

For Installation and use of the software please see the separate API “TrackerCal” users manual and the documentation supplied with your application software.

13 Maintenance/Storage Introduction

This section provides information on maintenance of optical components, and proper storage of the system. The laser and electronics used in the system are not user serviceable. Should the laser or servo systems fail to operate, the entire system should be returned to API for corrective actions. Please see the troubleshooting section of this manual for answers to common problems.

On The Job Storage

With any multi-day operation of the instrument it is common practice to leave the instrument set up overnight to lessen startup time the following morning. Please follow the recommendations below when leaving the instrument set up between jobs:

- The Power (Laser) switch may be left on with no damage to the laser system.
- Turn the Servo (Motor) switch to the off position to safely disable the motors.
- Place the lens cap over the laser aperture.
- If the environment is particularly dirty, place the dust cover over the instrument.

Storage

The tracking system is a precision measuring device and should be handled with the same type of care as any laboratory instrument. All optical components should be kept clean and free of contaminants. The tracking system should be stored in the provided carrying case. The carrying case with the tracker should be stored in an environment comparable to the test area to ensure optimal thermal stability with the working environment.

Optical Cleaning Procedures

The optics used in the 3D Laser Tracker 3 may be damaged by improper or unnecessary cleaning, and should only be cleaned when they are noticeably dirty. When the optics requires cleaning, it is recommended that only the affected area be cleaned rather than the entire surface.

Recommended Cleaning Materials

The following items are recommended for cleaning the optical devices used in the Tracker 3:

1. Dust Blower, filtered dry nitrogen
2. Methanol and acetone
3. Dust free tissue
4. Cotton Swabs with wooden or paper stems (methanol and acetone dissolve plastic)
5. Mild, neutral soap, 1% in distilled water

WARNING:

Both methanol and acetone are toxic and flammable.

**The cleaning process should be performed in an open area,
away from any source of spark or flame.**

CAUTION:

Do not attempt to wash off any surface with running fluids.

Cleaning Loose Particles from Optical Surfaces

Dust and loose particles can adhere tightly to the optical surface because of static electricity. Most of the particles can be removed with a low-pressure air stream. Any remaining particles can be removed with a wet lens tissue. Acetone promotes rapid drying of the surface to eliminate streaks.

Getting Help

14 Getting Help with API's Products

API Software Products

TrackerCalib and supporting metrology software products used with the Laser Tracker 3 contains help features that covers a range of topics.

API Publications

The setup of the laser tracker, and use of the Laser Tracker 3 are included in this manual. The TrackCalib User Manual discusses how to perform diagnostic checks and completing calibration routines. Another API documentation SpatialAnalyzer User's Guide details the use of the Spatial Analyzer with the Laser Tracker 3.

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:

Mailing address - USA Office

15000 Johns Hopkins Drive
Rockville, Maryland 20850

Telephone

Contact the help desk at (301) 330-8100 between the hours of 8:30AM and 6:00PM 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.

International - Beijing Office

Rm. 1511, Block B Lucky Tower
#3 Dong San Huan Bei Lu
Chao Yang District, Beijing 100027
Tel 0086 010 84518793 Fax 0086 010 8451879

15 Troubleshooting

Tracker Does Not Power Up

1. Turn the Power and Servo switches on the Controller to the “OFF” or “O” position.
2. Verify that the outlet being used operates in the 100 to 263 V A/C range. If it does not, an adaptor or power supply may need to be used. Verify that the power cord is UL Listed and/or CSA Certified rated 300 Volts AC, 18 AWG, 75°C. Operating the Tracker without the protective earth (ground) connection intact may endanger the operator or the system. Do not use an outlet or extension cord with only two prongs. Verify that the power source is live by plugging in an appliance or tool.
3. Verify that the cable from the Controller to the Tracker is not damaged and that it is securely connected at both ends.
4. Verify that the weather station and serial cable are securely connected to the Controller (The serial cable does not have to be connected to the computer at this point, but will need to be connected prior to opening any software.)
5. Inspect the Controller power cable for any damage. If it appears damaged, replace it with a cord that is UL Listed and/or CSA Certified rated 300 Volts AC, 18 AWG, 75°C .
6. Connect the power cable securely into the Controller and securely into the outlet. If the plug fits loosely into the outlet, it may be necessary to gently bend the flat prongs outward very slightly to ensure a solid connection.
7. Turn the Power switch to the “ON” or “I” position.
8. **WARNING: NEVER CONNECT OR DISCONNECT THE TRACKER-CONTROLLER CABLE WITH THE POWER ON. THIS MAY DAMAGE THE ELECTRONICS.**
9. If the unit continues to malfunction please contact API for assistance.

Laser Does Not Appear to be Operating

1. Do not stare directly into the laser to check if it is operating. Instead, place a piece of paper in the path of the beam, or point the Tracker at a wall or floor. A bright red dot will appear when the laser is operating.

2. Verify Tracker is properly connected, and power is on. If the Tracker is not connected to the Controller, turn the power off before making the connection.
3. Verify that the aperture cover at the front of the laser head has been removed.
4. Verify that the red LED at the front of the laser is continuously lit. If it is blinking, the laser is not ready. Allow at least 15 minutes after turning the power on for the laser to “warm up” (API recommends at least 1 hour for accurate measurement.)
5. Place a piece of white paper several inches from the front of the laser head in the direction of the beam. If a bright red dot appears, the laser is operating.
6. During warm-up the laser beam intensity will vary. This is normal during warm-up. When the Red LED is steady the laser intensity will be constant.
7. If the laser lens appears to be contaminated follow the optical cleaning procedure in this user’s manual.
8. If the unit continues to malfunction please contact API for assistance.

Large Deviations in Measurements or Backsights

Confirm secure mounting of the laser tracker setup. Most deviations can result from movement of the instrument caused by an insecure mounting.

Low Return Intensity (ADM or IFM) and/or Difficulty Tracking

Check SMR (target) for defects. Use another SMR and see if the same performance is observed. Many tracking problems are the result of the target and not the system.

Computer Cannot Connect to Tracker

Review Section on Software configuration (TCP/IP settings). Also, consult the TrackerCal v3 manual for further computer troubleshooting.