Operations Manual

Bore9

Alignment Software for the R-1307 Readout

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HAMAR LASER INSTRUMENTS, INC.
www.hamarlaser.com

Five Ye Olde Road, Danbury, CT 06810
Phone: (800) 826-6185 Fax: (203) 730-4611

WARRANTY

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This warranty is not applicable to instruments or other articles of equipment manufactured by other companies and limited by a warranty extending for less than one year. In such an event, the more limited warranty applies to said instrument or article of equipment.

This warranty shall not apply to any instrument or other article of equipment which shall have been repaired or altered outside the Hamar factory, nor which has been subject to misuse, negligence, or use not in accord with instructions furnished by the manufacturer.

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Bore9 Alignment Software for the R-1307 Readout

Bore9 Alignment Software measures and displays the alignment of multiple bores. It measures bore straightness (axis centering) and size (diameter) using one of the bores as a reference. Applications include turbines, engine blocks, rotary compressors, extruder barrels, gun barrels, hydraulic cylinders and printing press bearings.

Compensating for Mounting Errors

Target and laser mounting errors must be compensated for in order to achieve accurate results in bore and spindle work. Bore9 uses the NORMIN method developed by Hamar Laser. The NORMIN method is a quick and precise way of canceling out these errors and eliminates the need for complicated, expensive fixtures. The word NORMIN is a contraction of **NORM**al-**IN**verted, which briefly describes the method.

One unit (target or laser) is set in the NORMal (cable down) position, and the other rotated 180 degrees to the INverted (cable up) position. A set of INverted readings is taken. Then the laser and target are both set in the NORMal (cable down) position and the readings are recorded. In some cases, three readings are taken: target NORMal and laser INverted, laser NORMal and target INverted, and both units NORMal. The readings are then averaged to cancel out both centering and angular mounting errors and provide a very accurate result. A detailed description of the NORMIN procedure can be found in Appendix A, beginning on Page 46.

Bore9 Features

- **Live display**
  The plot displays move with each adjustment, allowing the user to see the misalignment and correct it easily.
- **Offsets**
  Bore9 allows the user to develop or enter various offsets or error corrections. The offsets can be toggled on and off as required and include the following capabilities:
  - Zero
  - Buckin
  - Manual Offset
  - Align Target
- **Save, print and analyze recorded data**

Preparing for an Alignment

There are several preparations that need to be made before beginning a measurement or alignment process. Ensure that accurate records are kept for all procedures.

Hardware Preparation

- Determine what hardware is necessary to perform the alignment, including the laser, target, mounting fixtures, readouts or interface, cables, etc. Make a note of the target model number so that the information can be entered into the program setup.
- If a test or measurement is expected to take more than 3-4 hours, be sure to connect portable computers, interfaces, and other battery-operated devices to their external power supplies.
- Observe safety precautions when setting up hardware. Lock out machines for stationary procedures. If a machine is running, set up barriers and/or warning signs and route all cables away from moving parts. Clean and check all equipment, fixtures, and mounting surfaces before beginning any alignment process.

The A-516 Self-Centering Target

The A-516 Target is a deep-bore, self-centering target with a 20x20 mm PSD (position sensing device). Other targets with a 20x20 mm PSD include the T-1218, T-1220 and T-1240.

The A-516 Target has a built-in adapter hub that uses measuring legs. These legs have special roller bearing tips for deep bore alignment checks. The target requires a customized set of M-516CL legs for each bore ID and an A-516P Quick Connect Insertion Pole with measuring tape.

Figure 1 – *The A-516 Target*

Setting up the A-516 Target

1. **Connect the Roller Legs**
   - Insert the M-516CL leg into the target, aligning the dowel pin in the slot.
   - Tighten the set screw.

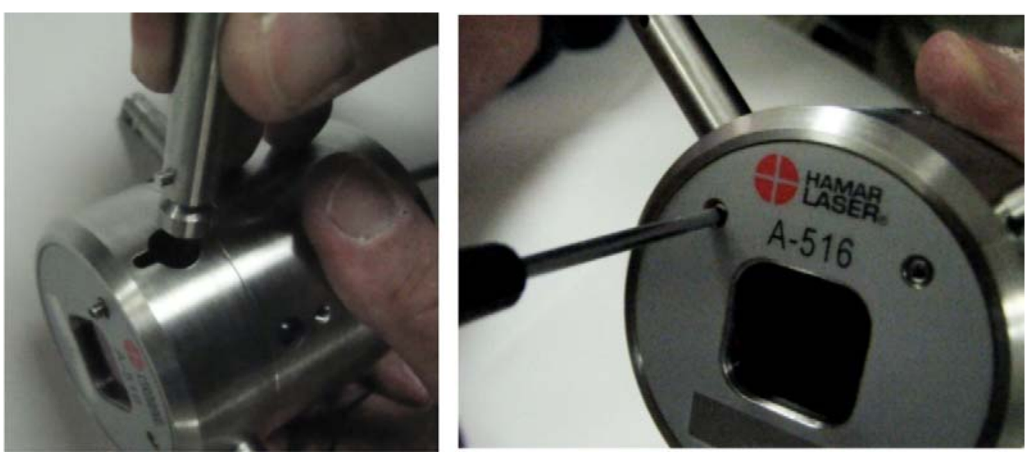


Figure 2 – *Connecting the M-616CL legs to the A-516 Target*

2. **Attaching the A-516P Pole Assembly**
   - Line up the pole assembly to the back of the A-516 target and screw in.
   - Tighten the set screw for the A-516P.

Figure 3 – *Attaching the A-516P Pole Assembly*

3. **Attaching the A-516P Pole Extension**
   - Push in the tabs to insert the pole extension.

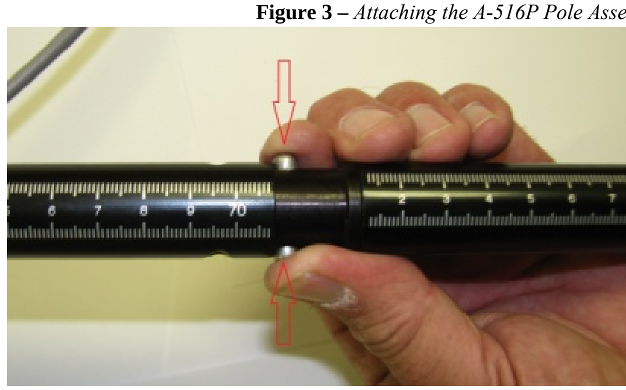


Figure 4 – *Attaching the A-516P Pole Extension*

4. **Inserting the A-516 assembly into the bore**
   - Hold the target by the by the extension pole and insert into the bore. The target legs will glide in on the rollers on the end of the legs.
   - Using the measuring points on the extension pole, line up the measuring point with edge of bore.

Figure 5 – *Inserting the A-516 Target into the bore*

Connecting to a Computer Interface

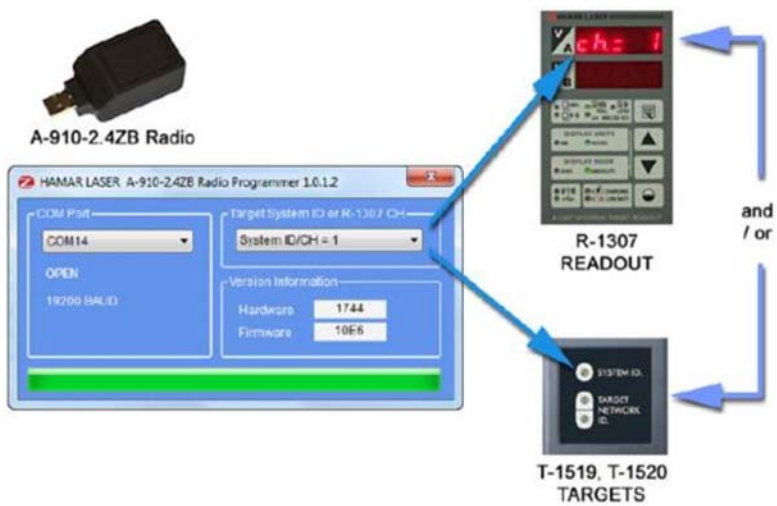
Hamar Laser’s computer interfaces couple with a portable computer to act as a readout and allow the use of the Bore9 program to perform calculations, display live laser beam-to-target position information, and plot results.

Figure 6 – *A-910-2.4ZB Interface*

- The **R-358 Interface** attaches to the computer with an RS-232 cable and is powered by a lithium ion battery or an AC adapter. The R-358 is available in both standard (.0001") and high-resolution (.00001") versions.
  Note: *Select R-358SR if using the now-discontinued R-355D*. See Appendix F on Page 60 for more information about the R-355D.
- The wireless **A-910 Interface** for Hamar Laser’s Type II Universal Wireless Targets incorporates a built in radio transceiver available in 900 MHz or 2.4 GHz. Operating through the A-910 Radio Transceiver/Hub, up to 99 Type II Targets may be connected as a Target System Group, and up to ten Target System Groups consisting of 99 targets per group may be used at one time. The 900MHz model has an indoor range of 300 feet (91 meters) and the 2.4 GHz model has an indoor range of 600 feet (1.83 meters). Data transmission is 4 mW and 50 mW respectively. See Appendix B on Page 51 for configuration instructions.
- The **A-910-2.4ZB Interface** is used for up to 99 targets. The A-910ZB is a very small, USB-powered 2.4GHz radio transceiver that can read up to four targets simultaneously. If you are using the A-910-2.4ZN Interface, please see Appendix E on Page 55 for configuration instructions.

Connecting to the A-910-2.4ZB Interface

1. Plug the A-910-2.4ZB Interface into a USB port on the computer.
2. Open the Bore9 Software.
3. Select the A-910-2.4ZB in the Target Setup.
   Note: *See* Appendix E *on* Page 55 *for complete installation and configuration instructions.*



Connecting to the R-358 Computer Interface

Note: *Before using the R-358 Computer Interface, ensure that the battery is fully charged or that the AC charger/adapter is plugged in. Make all connections with computer powered off.*

1. **Connect the target(s) to the INPUT connector on the front of the R-358 Interface.**
   The interface can support one 4-axis target. It can also support two 2-axis targets with the use of an optional splitter cable.

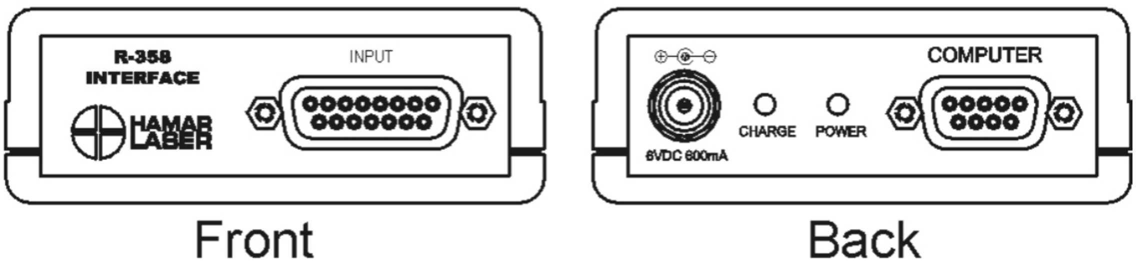


Figure 7 – *R-358 Computer Interface Connections*

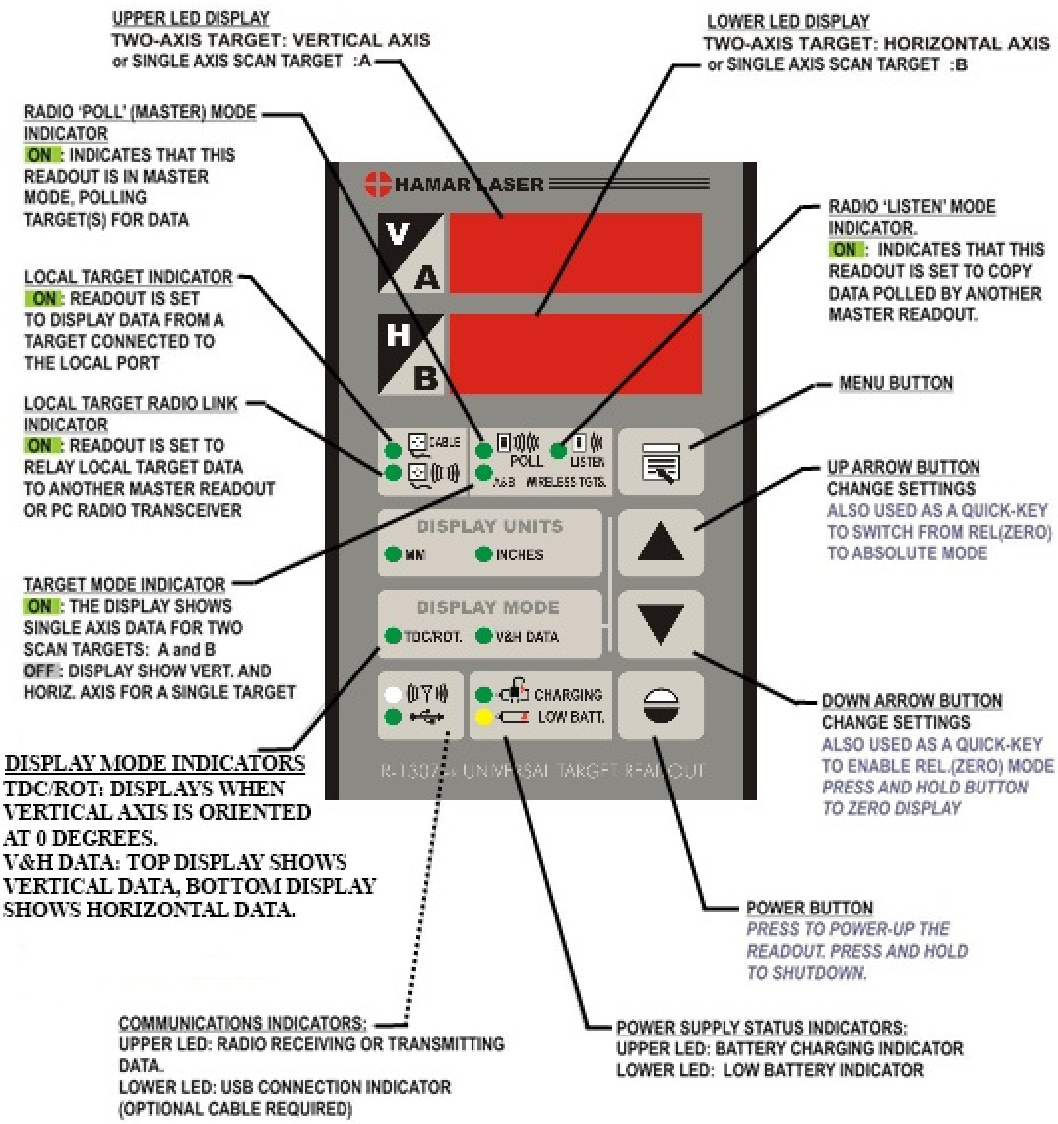
2. **Connect the R-358 Interface to the computer.**
   Connect the interface to the computer serial port using the standard RS-232 cable provided. The connector for the cable is located on the back of the unit and is labeled COMPUTER.
3. **Turn on the computer.**

The Model R-1307 Readout

The Model R-1307 Readout supports both wireless Unitargets, such as the A-1519, or local (cabled) targets. It is available with a radio frequency of either 900 MHz or 2.4 GHz ISM band. The R-1307 can be used as the primary readout or as an additional readout to copy position data captured by another R-1307.

Figure 8 – *R-1307 Readout*

R-1307+R Control Panel



Pulse/Continuous Modes (L-705 and L-706 Lasers)

The L-705 and L-706 Lasers are now equipped with a PULSE/CONTinuous switch, which manually switches the laser beam between *Pulsed* and *Fixed Beam Modes*. *Pulse Mode* automatically removes the effects of excess (ambient) background light for the R-1307 readouts, providing a more accurate reading. The R-1307 Readout is capable of supporting both Pulse Mode and Continuous Mode as well as storing up to nine different target calibration factors for multiple target users. These capabilities must be specified when ordering a system.

The chart below indicates the operational modes for Readouts/Computer Interfaces that operate with the L-705/L-706 Lasers:

Mode	Readouts	Computer Interfaces
Pulse	R-1307B-2.4ZB, R-1307BC, R-1307C, R-1307-900/2.4, R-1307-2.4ZB, R-1307+R	A-910-900/2.4 (when used with R-1307-900 or R-1307-2.4) A-910-2.4ZB
CONTinuous	R-307, R-307V	R-355C(D) or R-358

Notes:

1. *The T-261A and T-266 Targets do not support the Pulsed-Beam Mode and the system purchased is factory-configured to operate in CONTinuous mode when using these targets.*
2. *When using the L-700 Laser with the R-1307 and a 2-Axis Target, the system is factory-configured to operate in CONTinuous mode.*

Using TDC/ROT Mode with the R-1307 Readout

When a target is inserted into a bore, the target may rotate. This rotation can cause accuracy problems, (for example, a 5 degree rotation with a 1.00 mm vertical value will cause up to a 50 micron error).

To ensure maximum accuracy, it is important to ensure that the orientation of the alignment axes of the A-516 Self-Centering Target (or any other HLI bore target) relative to the bore is the same throughout the data-taking process. In other words, always keep the vertical axis oriented to 0 degrees (12:00).

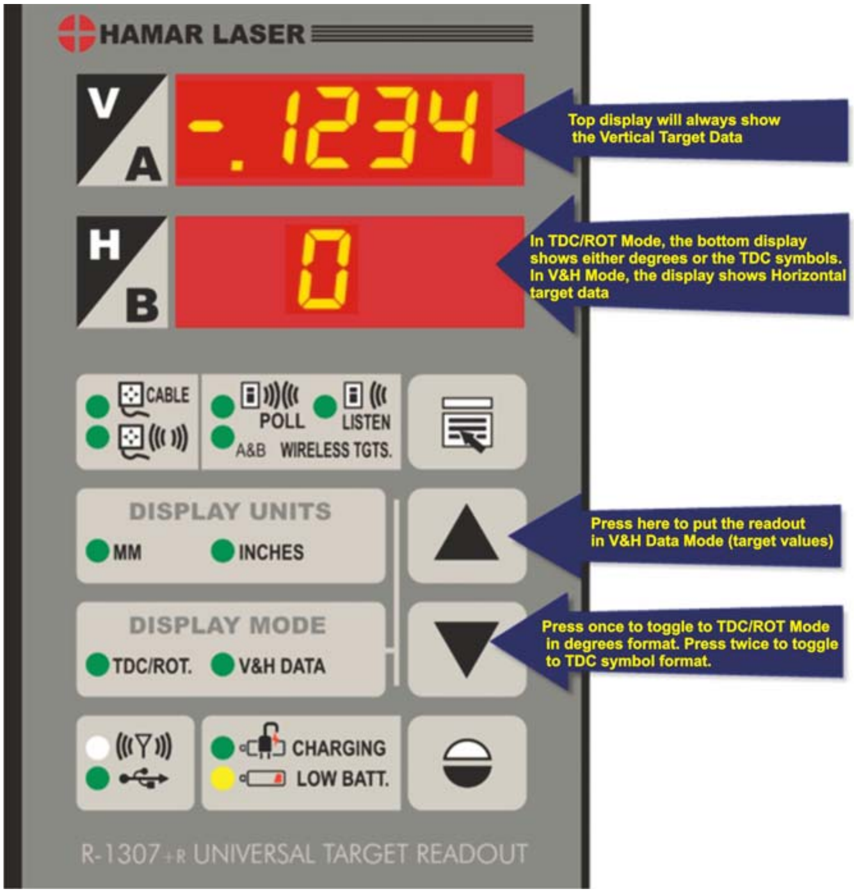


Figure 9 – *Using the R-1307+R in TDC/ROT Mode*

One way to do this is to use a level vial to keep track of the target's rotation orientation as it is inserted into the barrel. Another is to use an accelerometer inside the target housing. This example was done with the A-516, where an accelerometer supplies the rotation-axis "levelness" of the target so the user can maintain the rotation orientation of the target for each measurement point. The TDC/ROT indicator on the R-1307 lights when the target's vertical axis is at Top Dead Center (TDC). This indicates that the vertical axis is oriented to 12:00 (0 degrees). See Figure 11 for further information.

TDC/ROT Mode Procedure

1. Insert the A-516 Self-Centering Target into the bore.
2. Connect the R-1307 Readout and power on.
3. Press the **Down Arrow** on the R-1307 to activate TDC/ROT mode (see Figure 9). The **H** display indicates the rotation levelness of the target and the **V** display indicates the Vertical axis data.
   Note: *Press the* **Down Arrow** *again to switch back and forth between the level indicator (TDC Mode) and ROT Degrees Mode (see* Figure 11*). Press the* **UP Arrow** *to return it to H&V mode.*

Figure 10 – *H and V Displays*

4. Slowly rotate the target by pushing and pulling the target and rotating the pole until the **H** display shows the target to be at ± 1 degrees or the TDC indicator displays “0” or “-|” or “|-“(see the top left and second left screens in Figure 11). Take the data point by pressing the spacebar or clicking **Record** in Bore9.
   Note: *While the H display indicates the target’s rotation axis data, the alignment data transmitted by the R-1307 to the target includes the H axis data. Therefore, it is* **not** *necessary to switch back to H&V Mode to record the data point. When recording alignment, always keep the R-1307 in TDC/ROT mode.*
5. Repeat Steps 4 and 5 for each data point taken.

The following screens describe how the R-1307+R-2.4ZB Readout displays the rotation angle data for both the TDC and ROT modes.
Note: *In general, it is best to keep the rotation angle within +/- 1 degree from zero. For TDC mode, acceptable values are “|-“ , “0” or “-|”. See the screens below for more information.*

TDC Mode

Target rotation at 0 within ± 1°. **Good to take data.**	Target rotation ≥ 1° but <2°. **OK to take data.**	Target rotation ≥ 2° but <3°. **Do <u>NOT</u> take data.**	Target rotation ≥ 3° but <4°. **Do <u>NOT</u> take data.**	Target rotation ≥ 4° but < 5°. **Do <u>NOT</u> take data.**	Target rotation ≥ 5° but < 45°. **Do <u>NOT</u> take data.**	Target rotation < 45°. **Do <u>NOT</u> take data.**

ROT Mode

Target rotation at 0° within ± 0.9°. **OK to take data up to ± 2°.**	Target rotation at 12° within ± 0.9°. **Do <u>NOT</u> take data if rotation angle is ≥ 2.**	Limit of rotation display is ± 45°.	Target rotation > 45°. **Do <u>NOT</u> take data.**

Figure 11 – *R-1307 Readout TDC/ROT Mode*

Configuring the R-1307C, R-1307-900/2.4 or R-1307-2.4ZB for a Cabled (Local) Target

Note: *Shut off power to the readout before connecting or disconnecting a target from the local port.*

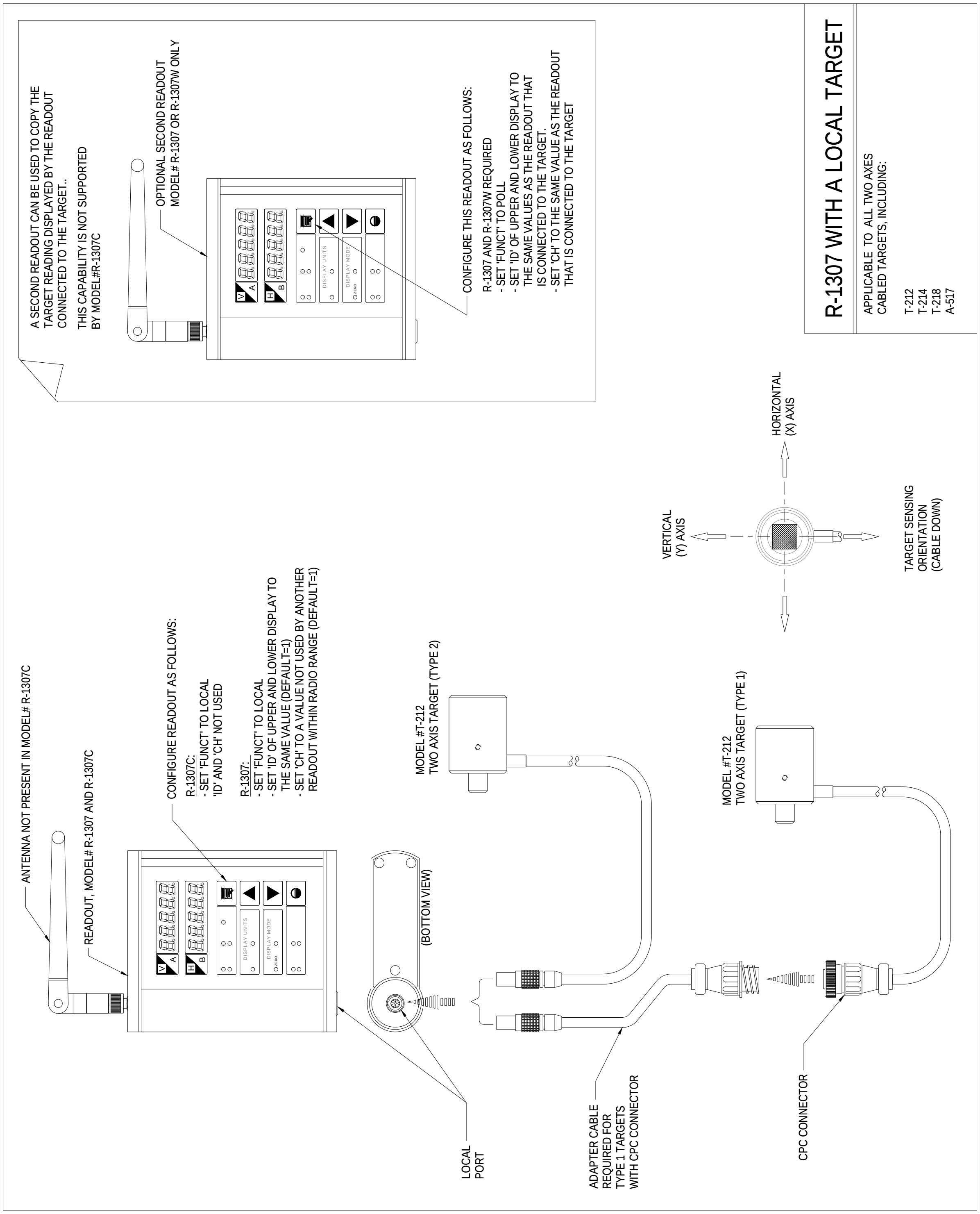
1. **Connect the cabled target to the local port of the readout**
2. **Press and hold the MENU button for approximately 2 seconds to enter configuration mode.**
3. **Set the Measurement Units**
   Press the MENU button until the upper display shows unit: _ Use the UP and DOWN arrow keys to select either inch for inches or mm for millimeters.
4. **Set the Dampening Level**
   Press the MENU button until the upper display shows AvErAGE. Use the UP and DOWN arrow keys to set the number of averages. Adjust this value as required to suit the application. The default for this application is 8. For long distance shots, use 16 or 32.
5. **Set the Readout Function to Local Target**
   Press the MENU button until the upper display shows Funct:. Use the UP and DOWN arrow keys to select Funct: LOCAL.
6. **Select the PSD descriptor applicable to your target**
   Press the MENU button until the upper display shows tGt: nn, where nn designates the target calibration factor number. There is one calibration record for each target purchased. The R-1307 can store up to 9 records. Each calibration record in the R-1307 has the following target types:
   - TGT=0 (for HLI use only. Do not use)
   - TGT = nn, P.10.10 (10x10 mm sensor- pulsed beam mode)
   - TGT = nn, F.10.10 (10x10 mm sensor- fixed beam mode)
   - TGT = nn, P.4.4 (4x4 mm sensor- pulsed beam mode)
   - TGT = nn, F.4.4 (4x4 mm sensor- fixed beam mode)
   - TGT = nn, P.20.20 (20x20 mm sensor- pulsed beam mode)
   - TGT = nn, F.20.20 (20x20 mm sensor- fixed beam mode)
   - TGT = nn, P.40.40 (40x40 mm sensor- pulsed beam mode)
   - TGT = nn, F.40.40 (40x40 mm sensor- fixed beam mode)

   nn= R-1037 Readout number and matching target number

Press the UP or DOWN arrow to select the correct target number, which will change the second window. For example, tGt:02 F_ 10_ 10 or tGt:02 P_ 10_ 10 for R-1307 #2. The PSD sensor size and type is fixed to the target calibration record.

Warning: Targets are matched to specific calibration records in the R-1307 Readouts. For example, Target #1 must be connected to Calibration Record #1 in the R-1307 or the calibration is void. However, each R-1307 can have up to 9 target records, so up to 9 different target calibration records can be stored in each R-1307. When there are multiple calibration records, the record ID must match the target ID, so if you have Target #1, you should select TGT=01 to select the matching calibration factors.

7. **To exit configuration mode, press and hold the MENU button for approximately three seconds until the display returns to normal mode.**
   The R-1307 will also return to normal mode automatically after approximately four seconds of inactivity.


R-1307 WITH A LOCAL TARGET
APPLICABLE TO ALL TWO AXES CABLED TARGETS, INCLUDING:
T-212
T-214
T-218
A-517
A SECOND READOUT CAN BE USED TO COPY THE TARGET READING DISPLAYED BY THE READOUT CONNECTED TO THE TARGET..
THIS CAPABILITY IS NOT SUPPORTED BY MODEL#R-1307C
OPTIONAL SECOND READOUT MODEL# R-1307 OR R-1307W ONLY
CONFIGURE THIS READOUT AS FOLLOWS:
R-1307 AND R-1307W REQUIRED
- SET 'FUNCT' TO POLL
- SET 'ID' OF UPPER AND LOWER DISPLAY TO THE SAME VALUES AS THE READOUT THAT IS CONNECTED TO THE TARGET.
- SET 'CH' TO THE SAME VALUE AS THE READOUT THAT IS CONNECTED TO THE TARGET
ANTENNA NOT PRESENT IN MODEL# R-1307C
READOUT, MODEL# R-1307 AND R-1307C
CONFIGURE READOUT AS FOLLOWS:
R-1307C:
- SET 'FUNCT' TO LOCAL
'ID' AND 'CH' NOT USED
R-1307:
- SET 'FUNCT' TO LOCAL
- SET 'ID' OF UPPER AND LOWER DISPLAY TO THE SAME VALUE (DEFAULT=1)
- SET 'CH' TO A VALUE NOT USED BY ANOTHER READOUT WITHIN RADIO RANGE (DEFAULT=1)
(BOTTOM VIEW)
MODEL #T-212
TWO AXIS TARGET (TYPE 2)
MODEL #T-212
TWO AXIS TARGET (TYPE 1)
VERTICAL (Y) AXIS
HORIZONTAL (X) AXIS
TARGET SENSING ORIENTATION (CABLE DOWN)
LOCAL PORT
ADAPTER CABLE REQUIRED FOR TYPE 1 TARGETS WITH CPC CONNECTOR
CPC CONNECTOR

Installing the Bore9 Alignment Software

System Requirements

1Ghz minimum, 1G RAM minimum (2G RAM recommended), 1.1G free disk space, Screen Resolution 1024x768 minimum.

The following Microsoft Windows® operating systems have been tested with Bore9:
Windows XP Professional 2002 SP3, Microsoft Vista Business SP1, Windows 7 Ultimate x64, Windows 7 Home Premium SP1.

The following Microsoft Windows operating systems have not been tested with Bore9:
Windows 7 Ultimate x86, Windows 7 Ultimate N, Windows 7 Enterprise x86, Windows 7 Enterprise N Windows 7 Enterprise x64, Windows 7 Professional x86, Windows 7 Professional N, Windows 7 Professional x64, Windows 7 Home Premium x86, Windows 7 Home Premium N, Windows 7 Home Premium x64, Windows Vista Ultimate, Windows Vista Enterprise, Windows Vista Enterprise x64 Edition, Windows Vista Home Premium, Windows Vista Home Premium x64 Edition, Windows XP Professional x64 Edition

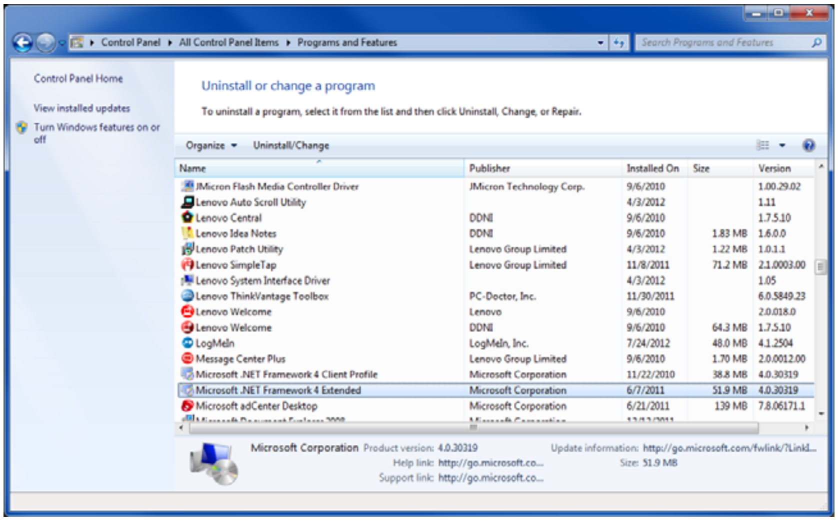
The following Microsoft Windows operating systems are *not* recommended for use with Bore9:
Windows7 Home Basic x86, Windows 7 Home Basic N, Windows Vista Home Basic, Windows XP Home Edition

Before installing the Bore9 software, ensure that your computer has the latest Windows Service Pack and critical updates. To find security updates, visit **www.windowupdates.com**. If you are installing on Windows XP 64 bit or Windows 2003 you might need to install the Windows Imaging Component.
The Windows Imaging Component 32-bit can be found at:
http://www.microsoft.com/en-us/download/details.aspx?id=32.
The Windows Imaging Component 64-bit can be found at:
http://www.microsoft.com/en-us/download/details.aspx?id-1385.

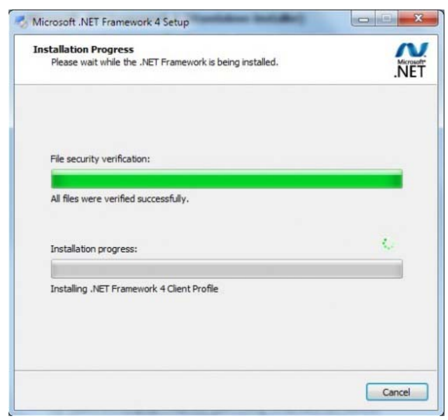
In addition, software for reading .pdf files, such as Adobe Acrobat, is necessary in order to access the program documentation and read alignment files saved in this format.

Installing Microsoft .NET Framework 4

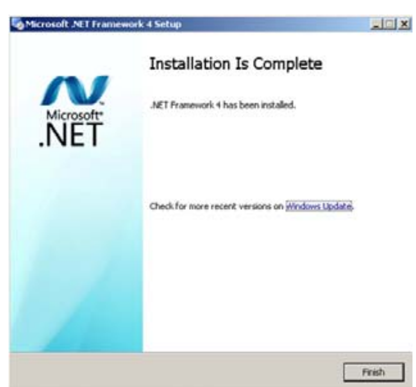
You must have Microsoft .NET Framework installed before installing the Bore9 software. If you are unsure about whether you have Microsoft .NET Framework 4 installed on your computer, open the Control Panel. For Windows XP users, select **Add/Remove Programs**; for Window 7 users, select **Programs and Features**. Scroll down the list of installed software to locate Microsoft .NET Framework 4. If the program is not installed, follow the instructions for installation on Page 13.



1. To install Microsoft .NET Framework 4, locate the folder **MS_Framework_4_X86_X64** on the Bore9 installation CD. Open the folder and double-click **DOTNETFX40_FULL_X86_X64** to begin the installation. Follow the on-screen prompts to complete.



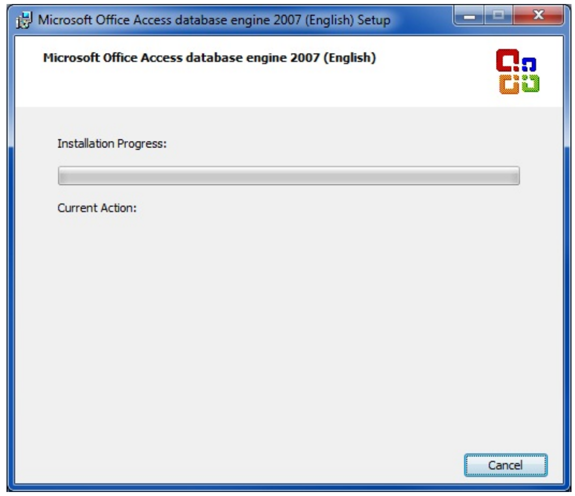
2. When the installation is complete, click **Finish** to close the installation program.



Installing Microsoft Access Database Engine

The Microsoft Access Database Engine must be installed on your computer before installing the Bore9 software. This file is usually present if you have a full version of Microsoft Office installed. If not, do the following:

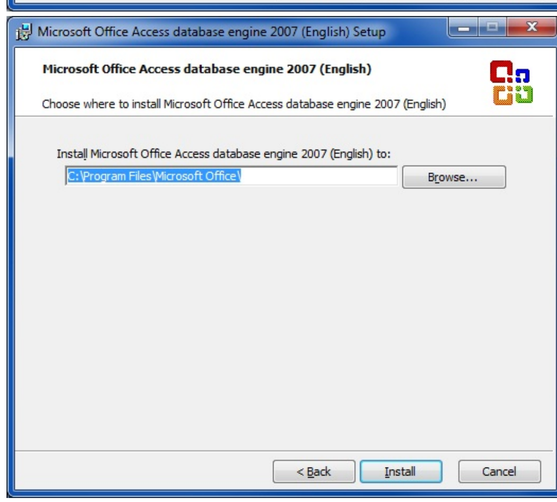
1. Open the folder on the Bore9 installation CD called **MSAccessDatabaseEngine**. Double-click the file **AccessDatabaseEngine** to begin the installation.



2. When prompted, check the box to accept the terms in the License Agreement and select **Next** to continue.

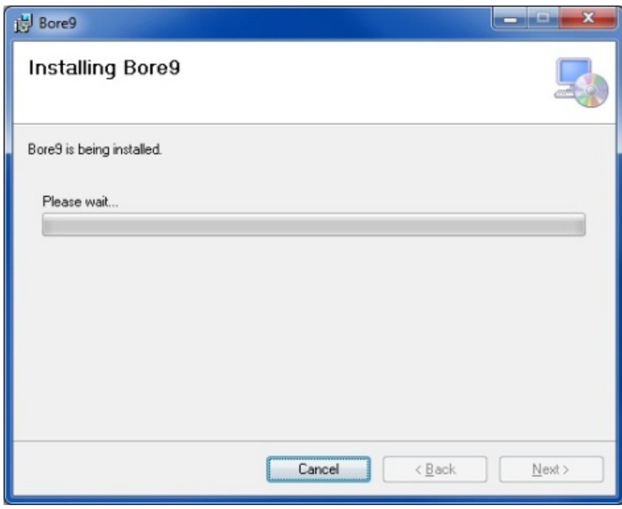
3. Choose the location to install Microsoft Office Access Database. The default location is automatically selected. To change the installation location, select **Browse** and specify a folder. Select **Install** to continue.

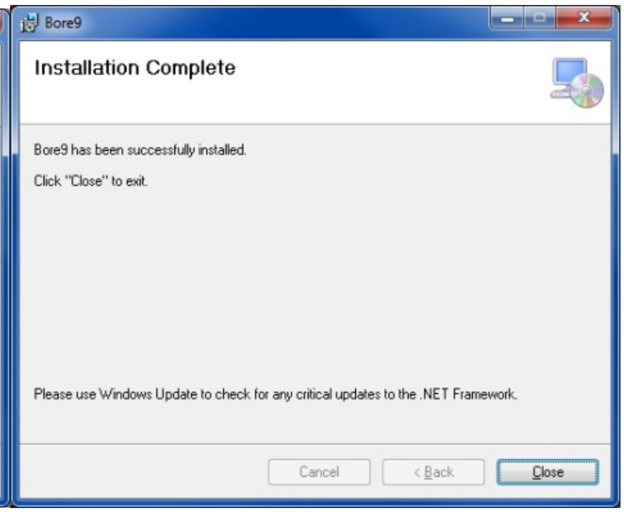
4. When installation is complete, click **Finish**.



Installing Bore9

1. Insert the program CD in the appropriate drive.
2. Click **Start** and select **Run**.
3. Type ***Drive letter:***/Setup, where **Drive letter** is the location of your CD ROM drive.
4. Follow the instructions on your screen.





Terminology and Conventions

This section is designed to introduce the actions used to select features and tasks while using the Bore9 software. For further information about the Windows interface, see the manual for your operating system.

The following terminology and conventions are used frequently in this book:

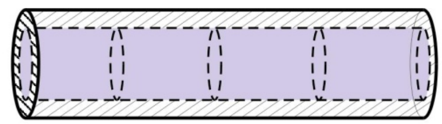
- Click = click once with the left mouse button
- Double click = click twice with the left mouse button
- Keyboard shortcuts
  - The Alt key can be used in combination with an underlined character to quickly access a screen or select a menu item. For example, pressing Alt-H while working in **Setup** displays information for the Help Screen.
- The names of buttons in the Bore9 program are referred to in bold type: for example, **OK**.

What is Bore Plot?

Bore Plot measures and displays the alignment of multiple bores. It measures bore straightness (axis centering) and size (diameter) using one of the bores as a reference. Applications include turbines, engine blocks, rotary compressors, extruder barrels, gun barrels, hydraulic cylinders and printing press bearings.

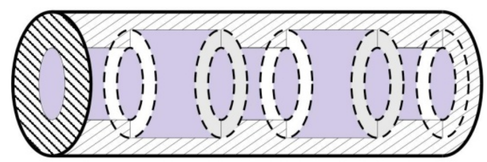
Continuous vs. Individual Bores

Continuous bores, such as rifle barrels, are single bores whose lengths are comparatively greater than their diameters. Measurements are taken by selecting points along the length of the continuous bore and taking readings at these cross sections.



Continuous Bore

Individual bores, such as bearing mounts in an engine block, are separate from one another and usually have lengths which are comparatively shorter than their diameters. One reading is taken at the center of each bore. If the bore is very narrow, the target may need to be mounted to a face and centered.



Individual Bores

Error Correction: The NORMIN Procedure

In order to get accurate results, target mounting and other errors must be compensated for in some fashion. The NORMIN Procedure was developed as a way of canceling out these errors. It is used in conjunction with simple fixtures and targets which allow inexpensive, precision measurement. For an in-depth discussion of the NORMIN Procedure, see Appendix A beginning on Page 46.

Measuring Alignment and Size

- To measure alignment of several bores, the laser should be bucked into (made parallel to) the two end bores. The target is then moved from bore to bore, and the deviation from the end bores is the measure of the misalignment of the bore. For the most accurate results, the same target should be used for all of the bores.

  Note: *The NORMIN procedure is necessary when performing bore* ***measurement*** *with any target. The NORMIN procedure is necessary for performing bore* ***alignment*** *with all bore targets* ***except*** *the A-510, A-512 and A-516 Self-Centering Targets.*

- To measure the sizes of several bores with respect to a reference bore, a reference bore with a known size is selected. The same target is moved from bore to bore (taking care to square up the target as closely as possible), taking error correction readings. The program calculates and displays the actual diameters of the individual bores.

The following are the steps common to the different types of bore measurement:

Hardware Setup

There are two ways of setting up Hamar Laser's bore alignment lasers:

1. **External Mount -** This method uses the L-111 Laser Stand and the L-102 Beam Translator to mount the laser outside the end bores. A target is moved from the near to far bores and the Buckin procedure is used to align the laser to the end bores.
2. **Internal Mount -** This method uses the L-708 Laser with the A-514 Self-Centering Bore Adapters to mount the laser in first end bore. The A-512 Target and a second A-514 Self-Centering Adapter is mounted in the second end bore. The laser is then tilted (steered) until the readout shows zero.

Bucking In

The Buckin procedure is needed to align the laser to bore reference points (or a spindle axis of rotation) so the alignment of other bores can be checked. The laser is positioned by adjusting the laser beam (using a beam translator) to center on the near target, and then adjusting the laser itself to point the beam on the target in the far position. This is repeated until the target gives the same reading in both positions.

Bore Setup

The user enters information In the Bore9 Setup Screen, such as the number of and distance between bores, the diameter of the reference bore, and the spacing between points to be measured.

Recording Data

The user moves the target from bore to bore, taking data. Data may be taken in any order desired, but the simplest way is to measure bores in numerical order). When taking NORMIN readings to cancel out errors, both the NORMal and INverted readings can be taken for one bore before moving to the next or the NORMal readings can be taken for each bore in one pass, and the INverted readings in the next.

Plotting Results

The resulting data is displayed on the screen as a two-view graph.

Saving, Printing, and Reviewing Results

Data may be saved and customized for review and for generating a printed report.

Getting Started with Bore9

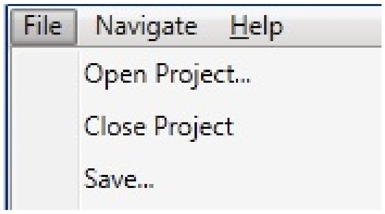
To begin using Bore9, double click the Bore9 icon or select the program from the Windows Start Menu. The initialization screen displays, providing the number of the current software version.

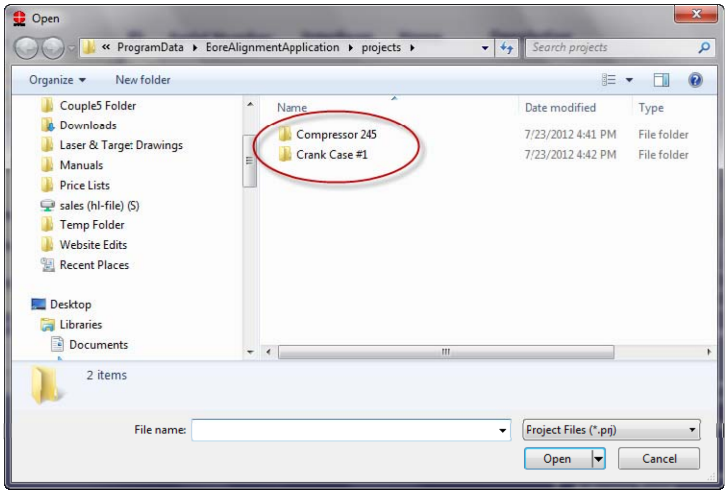
Creating a New Project File or Opening an Existing Project File

When the Bore9 software opens, the **Project Selection** screen displays. Here you can either open a saved project or create a new project. This screen can also be accessed by clicking **Open Project** from the **File Menu**.

To create a new project, click **New Project** and enter a project name.

To open a saved project file, click **Open Project** from the **File** menu**.** Double-click on the project folder and then click on the ***.prj** file to open the project.





Standard Features of the Bore9 Screens

Bore9 is structured to guide the user through the setup and data taking process. There are 5 steps to collecting bore straightness data:

Step 1 – Bore Setup – enter setup information for the alignment check such as number of bores, distance between bore, bore diameters and bore straightness tolerances.

Step 2 - Target Mounting Error - Here an easy procedure is followed to remove the mounting errors of the target if desired.

Step 3 – Laser Setup – Here on-screen instructions guide the user through setting up the laser and making it parallel to reference points.

Step 4 – Record Data – Here is where the bore straightness data is recorded. There are several different sets of data that can be taken here.

Step 5 –Results – Here the results of the data are plotted on a graph and a least-squares, best-fit data algorithm is applied to generate the straightness results and to determine if they are in or out of tolerance. Reports are also generated in this step.

The Menu Bar

The Menu Bar in the Bore9 program is located at the top of the screen under the program banner. The options are File, Navigate, and Help (Alt-H). Click with the mouse on one of these options to see the associated drop-down menu.

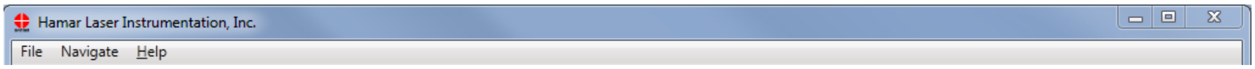
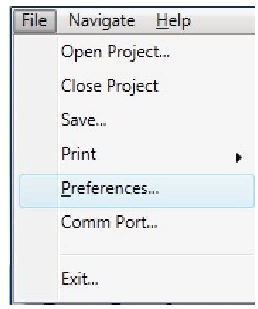


Figure 13 – *Bore9 Menu Bar*

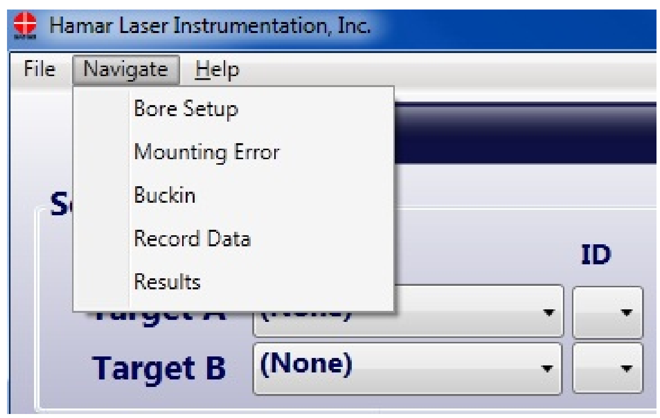
Once a Menu Bar dropdown menu opens, you can access any item on the menu by clicking it once with the mouse.



The File Menu

Open Project	Opens folder for user to select project to open.
Close Project	Closes currently open project.
Save Project	Saves current project.
Print Report	View and print current project.
Preferences	Contains Tabs for user to enter Company information, Units, Data Grid Displays, Decimal Displays, Target Setup and Record Mode.
Comm Port	Select the COM port that the computer interface is assigned to**.**
Exit Bore9	Stores all current settings, prompts the user to save any unsaved data, and exits the Read8 program.

The Navigate Menu



Bore Setup	Displays the Bore Setup screen (Step 1).
Mounting Error	Displays the Target Mounting Error screen (Step 2).
Buckin	Displays the Laser Buckin screen (Step 3).
Record Data	Displays the Record Data screen (Step 4).
Results	Displays the Results screen (Step 5).

The Help Menu

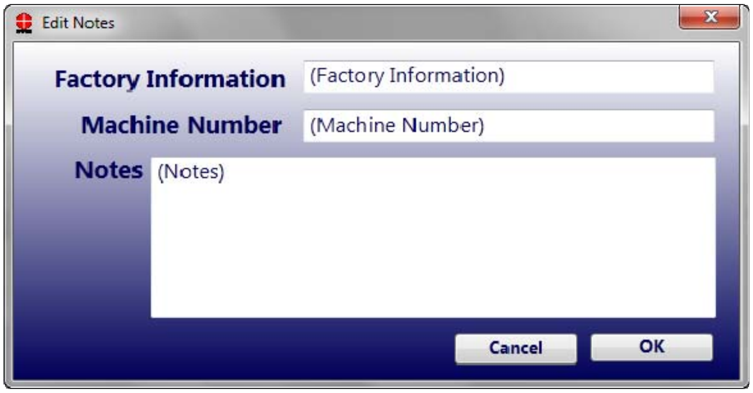
User Guide	Displays the User's Guide.
About	Displays the software information.

Navigating in Bore9 with the Status Bar

Click any number on the Status Bar to navigate to that step in the software. The right arrow and left arrow advances to the next screen.

Notes - Click **Notes** in the Status Bar to open a place to enter notes for the alignment. This information is printed in the report.

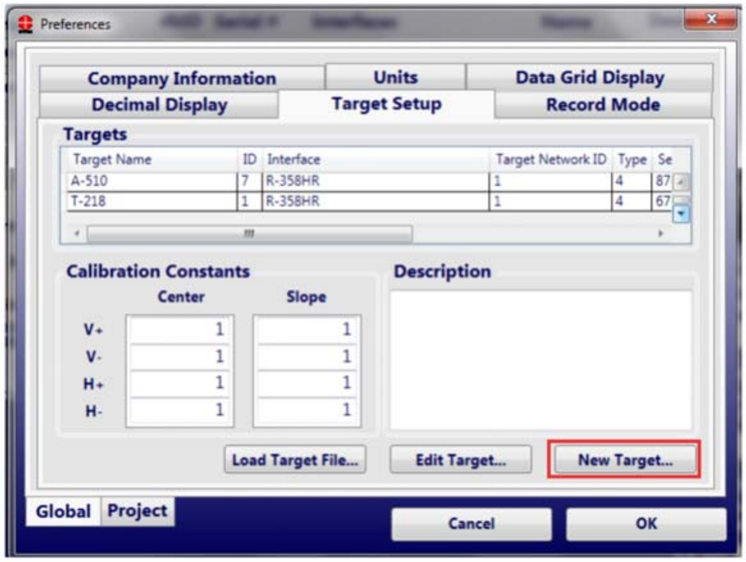
Units – displays the measurement units selected in **Preferences**.



Target Setup

When you buy a new system from HLI, your target setup should already be pre-configured into Bore9. If so, then please go to **Step 1— Setup** on Page 27 to select the target.

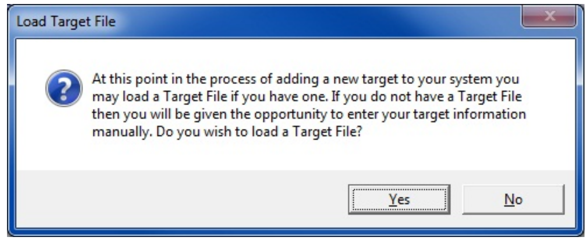
If the target setup data has not been entered, click **File>Preferences>Target Setup**. Click **New Target** to specify and set up a computer interface and to select a target that reflects the type of work being performed.



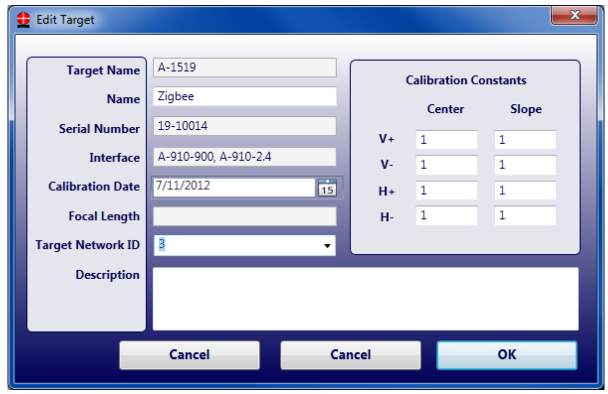
1. Select the type of Computer Interface you are using and click **Next**.

2. Select the target you are using and click **Next**. Hover the mouse cursor over a picture of a device to enlarge the picture.

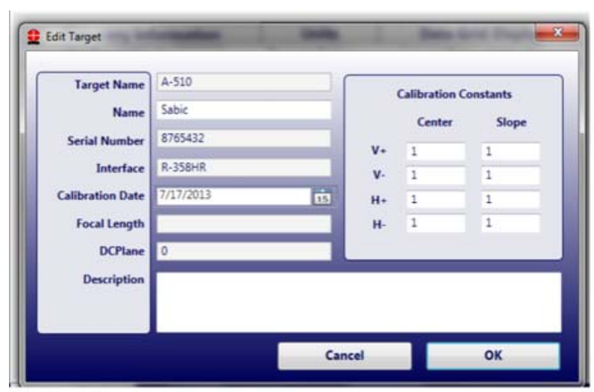
3. A popup displays asking you if you want to load calibration factors. If you have a disc with your Target File, you may load it now. Click **Yes** to load your configuration files. Select **No** to continue if you do not have a Target Files.



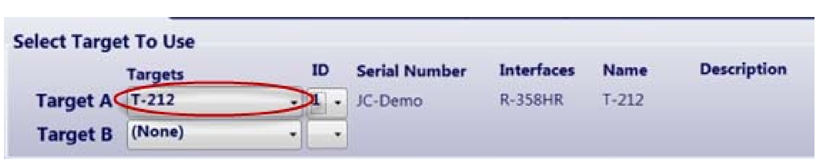
4. If you clicked **No, e**nter the required information: Target Name, Calibration Date, Target Network ID, (see *Setting the Target System ID and Target Network ID* on Page 58) and depending on your target, the Calibration Constants. The Serial Number, Focal Length and Description are optional. Note that the **Name** field can contain any name that will readily identify the target.



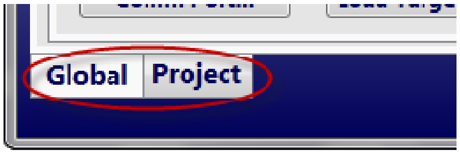
When using cabled targets, the Target Network ID field is replaced with DC Plane.



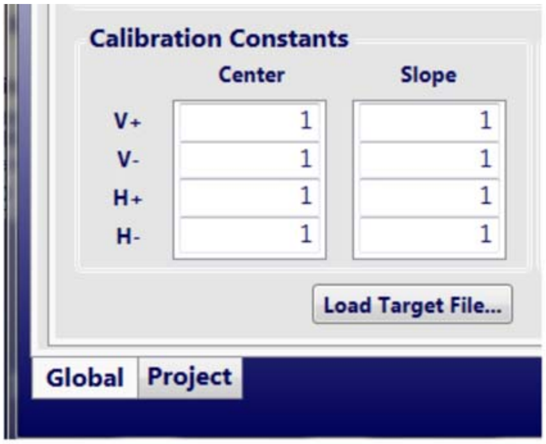
5. Select **Finish**. The target displays in the drop-down menu in the *Select Targets to Use* on Page 27.



Preferences

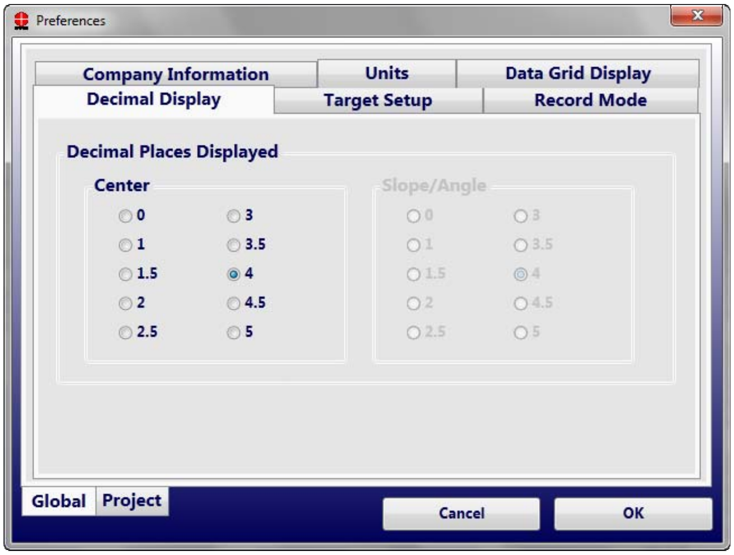


Note: *Please note the* **Global** *and* **Project** *tabs at the bottom of the* **Preferences** *screen. Any changes made when selecting* **Global** *affect the entire program. If a project file is opened with different preference settings, these setting can be changed by clicking* **Project** *and changing the preferences to those of that project.*



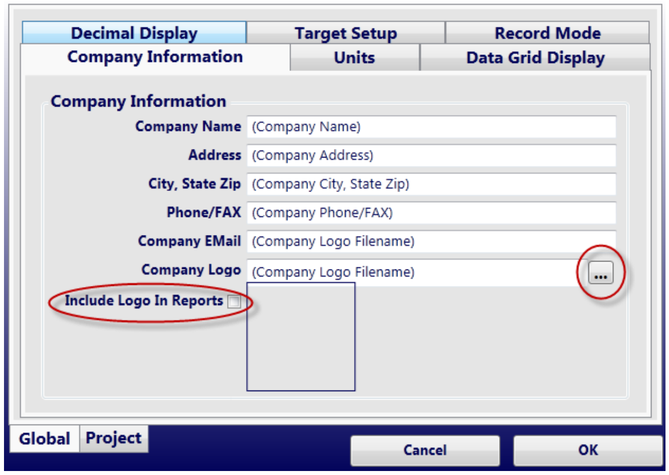
Calibration Constants

Click **Load Target File…** to load the calibrations constants for the target specified in the Target Setup. These files are found either on the CD that is sent with a target or in a folder where they've been copied to your hard drive. When entering the calibration constants from a printed list, click on each field and enter the value manually.



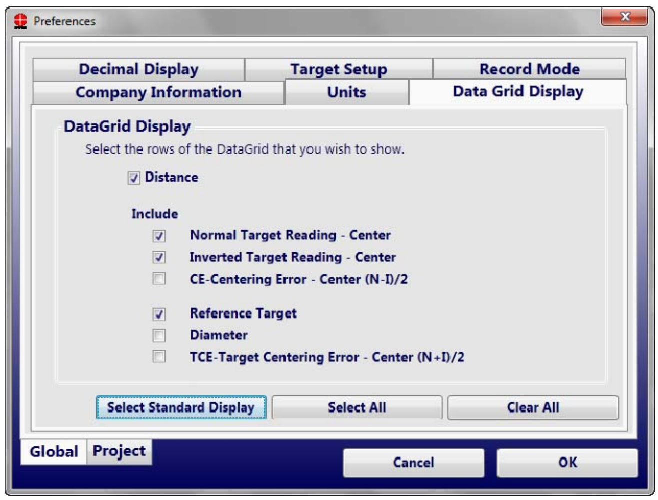
Decimal Display Tab – Select the desired number of decimal points to be used for alignment data displays.

Company Information Tab – Enter company contact information for the reports here. If you click **Include Logo in Reports** and then click **Browse**, you can import a company logo to display on the report.

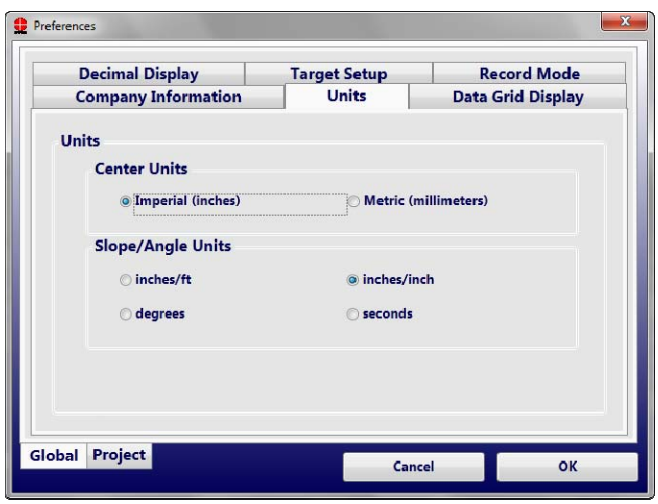


Data Grid Display Tab – This tab includes several options that control how Bore9 takes data and what analysis data is displayed in **Step 4– Take Data**. For most standard bore straightness applications using HLI's self-centering targets, click **Select Standard Display**. This will pre-select the data taking method of *Normal Target Reading – Center* and *Reference Target.*

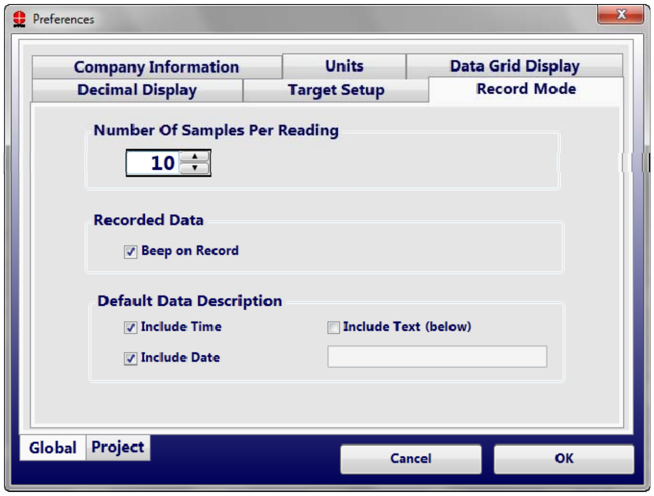
When using non-self-centering bore targets or to calculate bore diameter changes, select *Inverted Target Readings – Center, CE – Centering Error – Center (N-I)/2, Diameter and TCE – Target Centering Error – Center (N-I)/2.* In this case, you will be required take a NORMal and INverted reading at each bore location. This allows the software to remove any mounting errors (TCE) in the fixturing and also calculate the bore diameter change (if a reference bore diameter was entered in **Step 1 – Setup** on Page 27).



Units Tab – Use this tab to select Imperial (inches) or Metric (mm) and units for any slope calculations. Slopes in *Degrees* format display as a decimal number (for example, .012 degrees). *Seconds* format display in arc seconds (for example, 1.45 arc secs).



Record Mode Tab – Select the number of data samples for each data point, as well as a date and time stamp and comment for each data point.



Setting up a Bore Alignment Project

Step 1 - Setup

Enter the setup information for the bore alignment project, such as number of bores, distance between bores, targets being used, tolerances, etc.

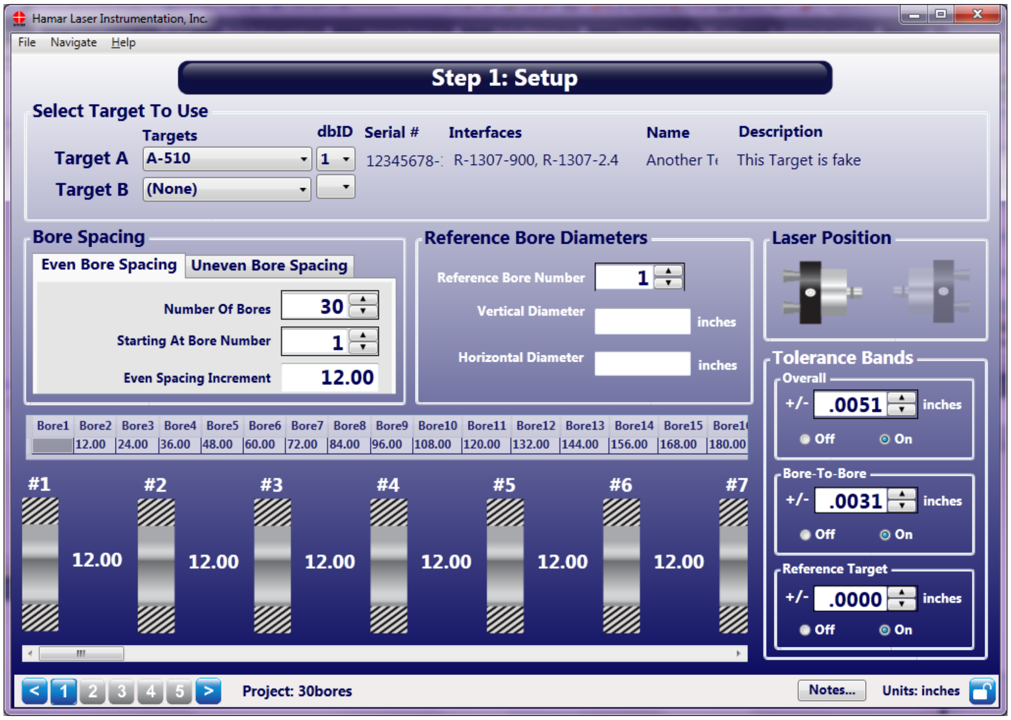
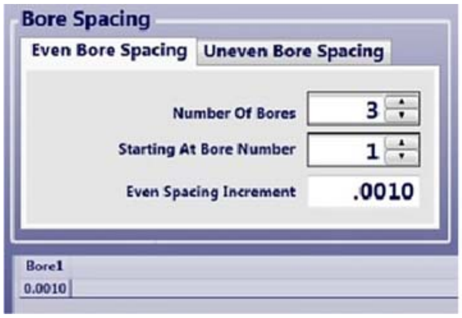


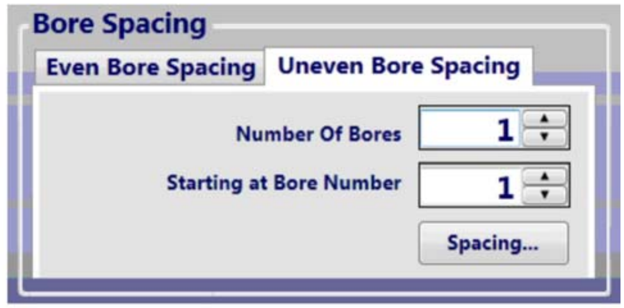
Figure 14 – *Initial Bore Plot screen with Bore Setup*

Select Target to Use – Select the target(s) to be used in the alignment setup. If the target you are using is not in the dropdown list, go to **Preferences>Target Setup** to add your target (see **Target Setup** on Page 22).

Number of Targets – For most bore applications, you will use only one target, so select a specific target by clicking the dropdown list for **Target A**. For two-target bore applications, also select a specific target for **Target B**.
Note: *You cannot select the same specific target for the A and B targets.*

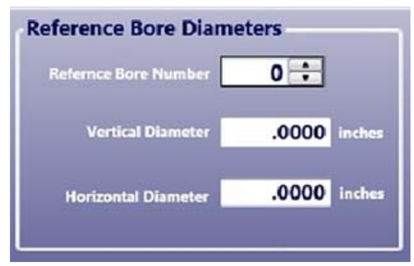
Bore Spacing – Specify whether the bores to be measured are evenly or unevenly spaced. If they are evenly spaced, enter the common distance between points and the starting value. If they are unevenly spaced, select the **Uneven Bore Spacing Tab** and enter the distance between individual points in the grid.



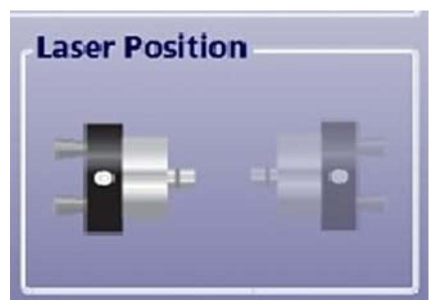


Number of Bores – Enter the number of points to be measured, either by typing in the number or using the up and down arrows. A minimum of three and a maximum of 50 points can be specified.

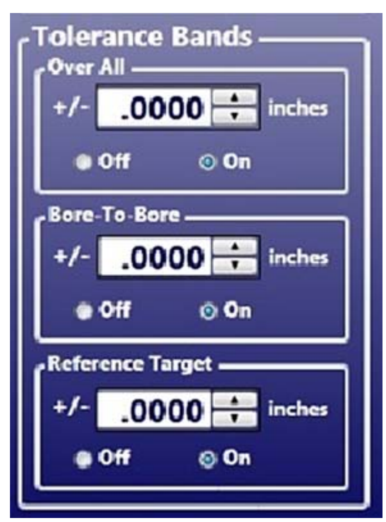
Reference Bore Diameters – If measuring several bores with respect to a reference bore, select the number of the bore to designate as a reference and supply its vertical and horizontal diameter.



Laser Position – Click on the graphic to select direction the laser is facing (left or right).



Tolerance Bands – When the Tolerance Bands feature is ON and a tolerance number is assigned, the graphs in Step 4 will indicate whether the overall straightness (the acceptable straightness misalignment tolerance over the whole range of data points) and bore-to-bore straightness data is within the values specified.



Bore To Bore – The acceptable deviation tolerance from one bore to the next.

When viewing the alignment graphs in Step 5, there will be a green tolerance band to indicate the overall bore straightness tolerance. If a data point falls outside of this area, it is out of overall tolerance. For bore-to-bore tolerance, a red dotted line between measurement points indicates an out-of-tolerance condition between those points.

Reference Target – A tolerance for the reference target when taking data in Step 4 using two targets, where one target (reference) is used to monitor laser drift. If the display values exceed the tolerance entered here, the Reference Target display turns red.

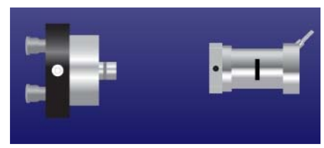
Step 2 – Target Mounting Error

The Target Mounting Error uses NORMIN readings to determine mounting and other errors in a fixture-mounted target and adjusts the display to remove the error from the readings. The user will be required to take 2 data points: 1) with the target in the NORMal position; and 2) with the target in the INverted position. The software calculates the mounting error and then applies it to the displayed and recorded data to remove the mounting error from all data points. This is a global target offset and is applied to all data unless it is turned off.

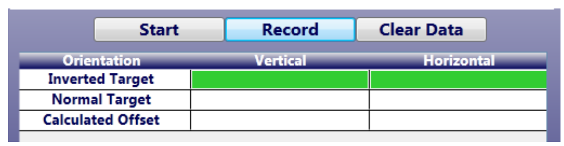
1. **Coarse-align the laser and target on the numerical display.**
   Ensure that that laser and target are in position and the numerical display is showing readings.

2. **Select TNID (Target Network ID)**.
   Using the drop-down arrow, select the TNID for the target you are using to perform the mounting error.

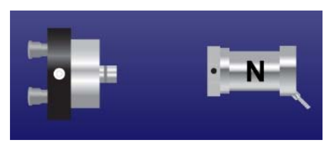
3. Click **Start**. The graphic showing the target with an **I** displays the proper orientation of the laser and target for taking the first reading. Invert the target so the cable is at 12:00.



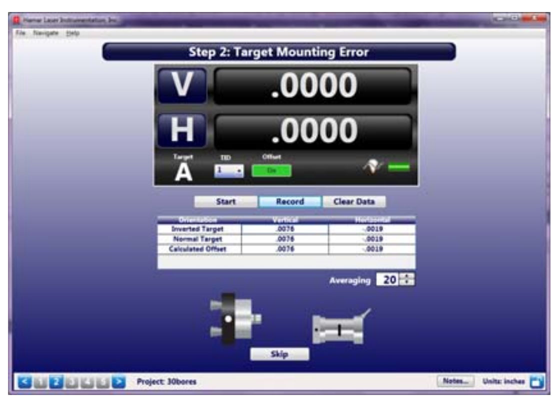
4. **Click Record to take a reading**.
   Ensure the target and fixture or bore adapter have been rotate to the INverted position. Click **Record** or press the spacebar to take a reading at the current position of the target and laser. Wait until the program takes all of its samples and displays the readings before performing the next step. The cursor moves automatically to the next field in the table and the graphic showing the laser and target orientation changes.



5. **Return the target to the NORMal position.**
   Rotate the target to NORMal position and level. (The target graphic now shows the letter **N**).



6. **Click Record to take a reading.**
   Press **Record** or press the spacebar to take a reading at the current position of the target and laser. Wait until the program takes all of its samples and displays the readings before performing the next step. Bore9 automatically calculates the mounting error offsets and applies them to the displayed reading. You will see the Offsets button show **ON**, indicating there are offsets being applied.

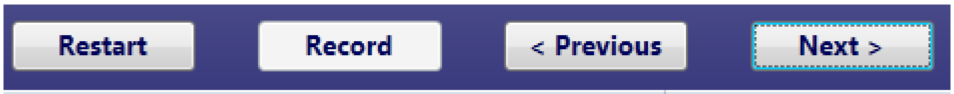


The plot screen now reads the laser beam misalignment (less fixture mounting errors). The **Offset** button and **Status Bar** indicate that Target Mounting Error offsets are **ON**. Any further readings display with this value subtracted.

Step 3 – Buckin (Laser Setup)

Buckin (laser setup) calculates set points for making a laser parallel to two reference points, usually the end bores. Use the Step 3 Buckin Wizard to guide you through the Buckin process.

While performing Step 3 – Buckin, the following options are available:



Restart – click to restart the Laser Buckin procedure.
Record – click when instructed to record data for laser setup.
Previous – click to return to the previous steps of the procedure.
Next – click to proceed to the next set of steps in the procedure.
Finished – **Next** becomes **Finished** when the last steps of the procedure display. Click **Finished** to proceed to Step 4—Record Data.

Laser Mounting Options

There are two ways to set up the laser: 1) Internal Mount or 2) External Mount. Select **Internal Mount** if using the L-708 Laser with the A-514 Self-Centering Adapters or if using any bore laser mounted directly in a spindle. Select **External Mount** if using the L-705/L-706/L-708 with the L-111 Laser Stand and L-102 Beam Translator.

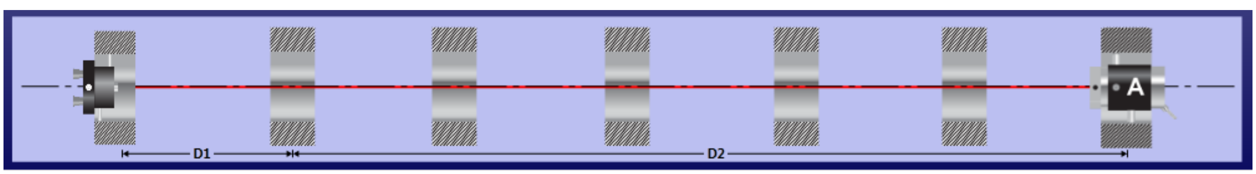


Figure 15 – *Bore Setup Display showing Internal Mount*

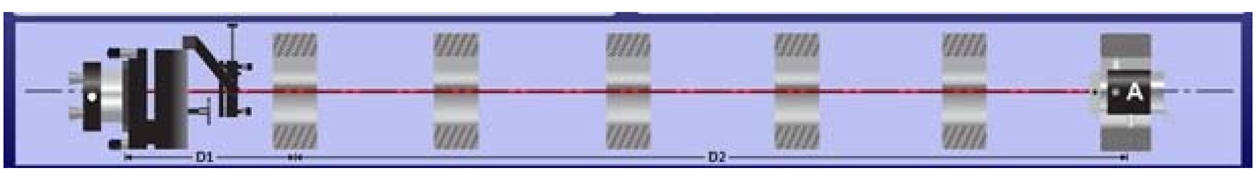
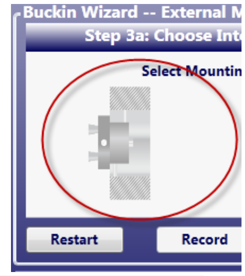


Figure 16 – *Bore Setup Display showing External Mount*

Internal Mount Laser

1. Select the laser mounting by clicking the Internal Mount graphic. Click **Next**.

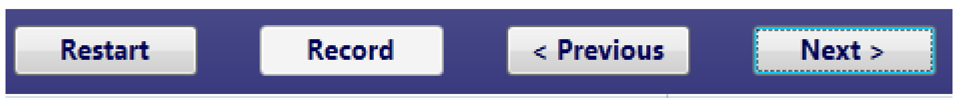


2. Select the target to use for the laser setup. If using one target, select Target A for the laser setup. If you have two targets, select Target A or Target B for the laser setup. Click **Next**.

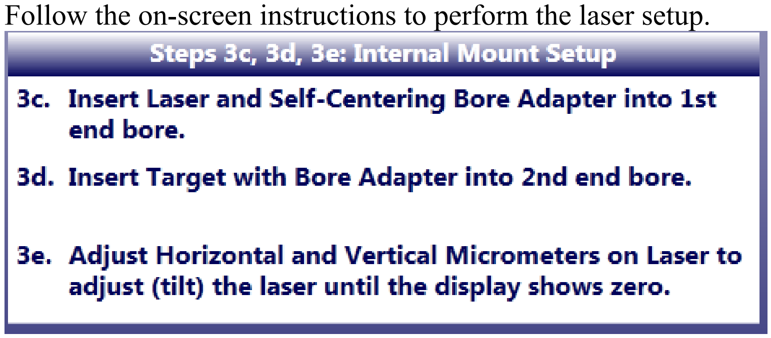
   Note: *For internal mount, you cannot choose A+B.*

Target A Selected

Target B Selected



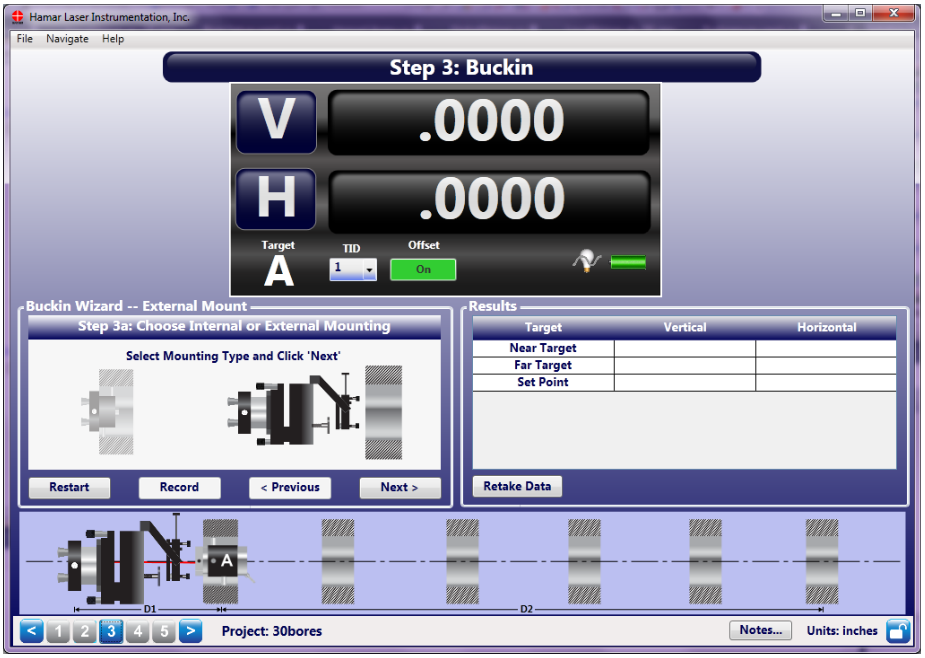
3. Follow the on-screen instructions to perform the laser setup.



4. Click **Finish** to go to Step 4—Record Data.

Internal Mount Laser Buckin – AOR Procedure

For applications such as extruder barrel alignment or spindle to bore alignment, the laser setup procedure is slightly different than the External or Internal Mount laser setups. The main difference is the laser needs to be adjusted so that it is parallel and co-linear to the Axis of Rotation (AOR) of a spindle. For this procedure, you will be using the live display to calculate a set of Set Points to steer the laser to make it co-linear to the spindle's AOR.



Laser Buckin AOR Procedure

Insert L-705/706/708 laser into spindle fixture and set the micrometers to the Nominal Settings. Turn on the laser to either **Pulsed Mode** (standard) or **Continuous Mode** (legacy).

1. Rotate the laser to the INverted position (Vertical Arrow pointed at 6:00) until the bubble is centered in the level vial window. **Note:** *There is a bubble vial on both the top (*NORMal*) and bottom (*INverted*) of the laser.*
2. Insert the target and bore adapter into the far bore location.
3. Ensure the laser is hitting the target. If not, then use *Rough Laser Buckin Using the Visual Method* described on Page 35 to visually buck in the laser.
4. Connect the R-1307 Readout (or R-358) and turn it on, making sure to match the laser mode (Pulsed or Continuous) in Step 1. See Page 7 for more details on changing the laser mode in the R-1307. Insert A-910-2.4ZB Radio Receiver into the USB port on the computer.
5. Open Bore9 and follow the steps in this manual (see Page 10) to configure the target to the readout so that the displays are showing live data.

6. Write down the V and H values for the INverted Position.
7. Rotate the spindle (holding the laser) 180 degrees to the NORMal position until the bubble is centered in the level vial window. Write down the V and H values.
8. Find the sum of the readings and divide by 2 (the number of readings) to calculate the laser *Set Points*.

$$\frac{\textbf{(Normal reading + Inverted reading)}}{\textbf{2}}$$

Calculations for vertical and horizontal readings must be done separately. The formulas for vertical and horizontal set points are:

$$\frac{\textbf{(Normal V + Inverted V)}}{\textbf{2}} = \textbf{V SET POINT}$$

$$\frac{\textbf{(Normal H + Inverted H)}}{\textbf{2}} = \textbf{H SET POINT}$$

Example of calculating the Vertical Set Point.

.

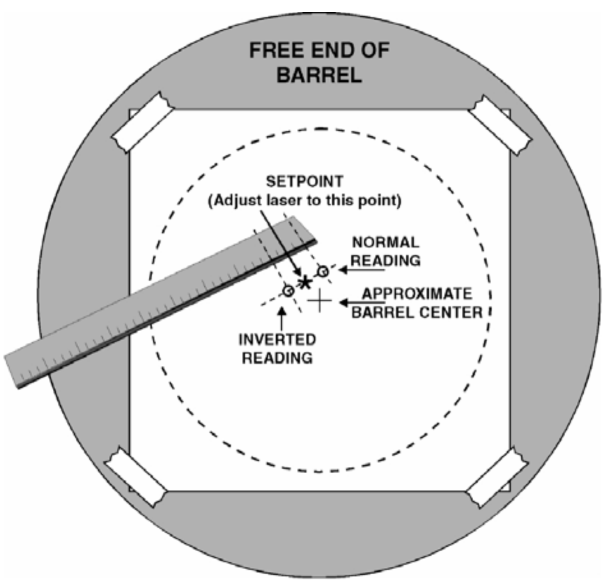
V_N	=	-.016		V_N	=	-.016
V_I	=	+.008		V_I	=	-.008
		-.008				-.024
Divide by 2				**Divide by 2**		
V Set Point = -.004				**V Set Point = -.012**		

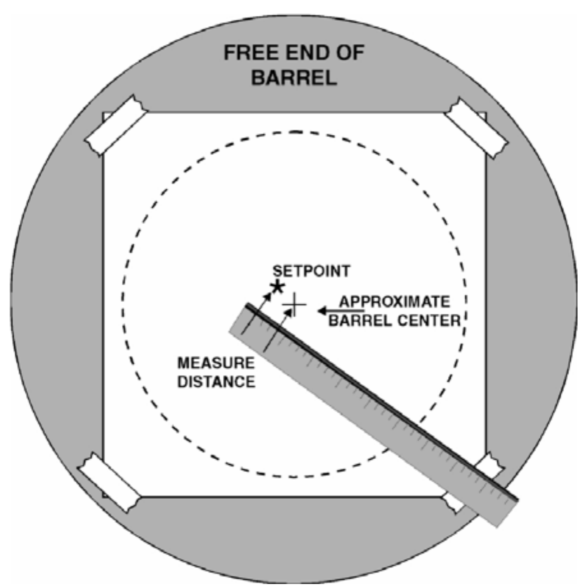
9. Turn the V & H micrometers (adjustment knobs on the L-708) until the V display value equals the *V Set Point* and the H display value equals the *H Set Point*.
10. Rotate the laser to the INverted position.
11. The V and H values should be the same as when the laser is in the NORMal position. If not, then repeat Steps 7 thru 11 until the values are the same within your desired tolerance.

Rough Laser Buckin Using the Visual Method

Note: This procedure is performed *without* the target inserted in the barrel.

1. **Cover the far end of the barrel with white paper.**
   Using a compass, draw a circle the same size as the bore diameter on a piece of white paper. Mark the center of the circle. Tape the paper to the far end of the barrel. The laser beam must be visible through the paper.
   Note: *Another way to make a circle in the paper is to lightly press the paper at the edge of the barrel and trace your fingers around the inside edge of the bore. This will create a round crease showing the ID of the barrel. Take a ruler to find the approximate center of the barrel and mark it with a pen/pencil.*
2. **Mark the laser beam location on the paper.**
   Set the laser to *Continuous Mode* (see Page 7). With the laser placed in the NORMal (upright) position, draw a small circle where the laser beam hits the paper.
3. **Invert the laser, spindle adapter and the spindle *AS A UNIT* and mark the laser beam location on the paper.**
   Using the bubble levels as a reference, rotate the spindle, laser, and adapter ***as one unit*** a total of 180 degrees until the level bubble on bottom of the laser is on top and centered. Now draw a small circle where the laser beam hits the paper.
   Note: *The laser, adapter, and spindle must be rotated* **AS ONE UNIT.** *Do not rotate the laser by itself. Also make sure that the circular level bubble is centered, or the results will not be accurate.*
4. **Measure to find the *Visual Set Point* and adjust the laser beam.**
   Using a ruler, measure the distance between the centers of both circles and mark the halfway point (see illustrations below) on the paper. This is the *Visual Set Point*. Turn the vertical and horizontal micrometers until the laser beam is centered on the *Visual Set Point* mark.

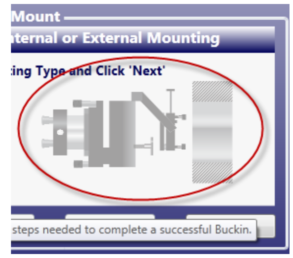


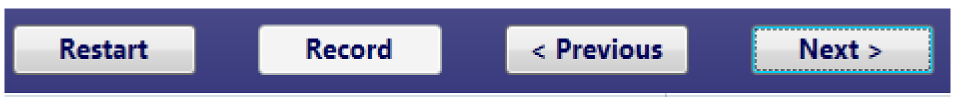


5. **Invert (rotate) the laser, spindle adapter and spindle *AS A UNIT* to ensure that the laser beam remains at the *Visual Set Point.***
   Following the instructions in Step 3, invert (rotate) the laser, spindle adapter and spindle *AS A UNIT* to ensure that the laser beam is still centered on the set point mark. If not, repeat Steps 2 thru 5 until the laser stays centered on the *Visual Set Point.*
6. **Measure the distance from the *Visual Set Point* to the mark at the center of the bore.**
   If the distance from the set point to the mark at the center of the circle is 0.4" (10 mm) or greater, move/align the end of the barrel until the center mark lines up with the *Visual Set Point* mark (see illustrations below). This is called a rough alignment.
7. **Complete the setup procedures.**
   Remove the paper and insert the target in the barrel, as described on Page 32. Then follow the Laser Buckin procedure.

External Mount Laser Procedure

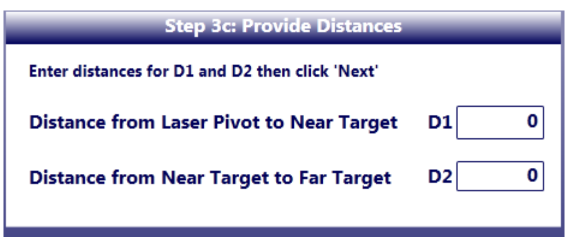
1. Select the laser mounting by clicking the External Mount graphic. Click **Next**.
2. Select the target to use for the laser setup. If using one target, select Target A for the laser setup. If you have two targets, select Target A or Target B for the laser setup. Click **Next**.



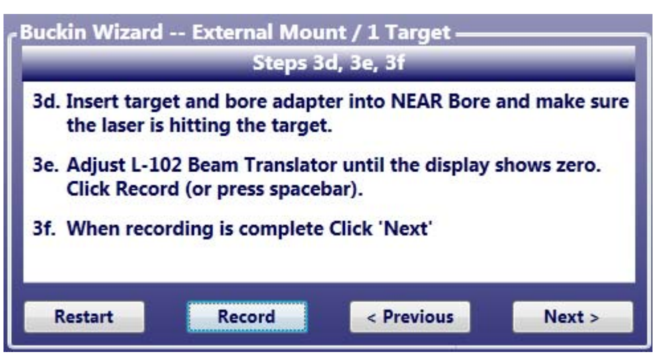


3. Enter distances as described. For example:

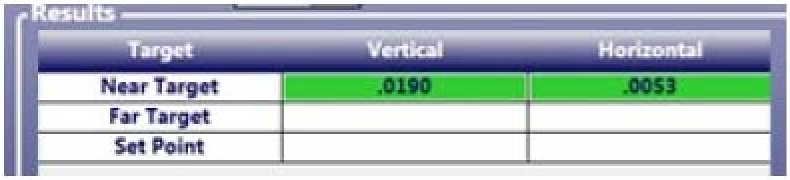
   Distance from Laser Pivot to Near Target D1 = 4.46
   Distance from Near Target to Far Target D2 = 12.67



4. Follow the on-screen instructions to record data for Near Point and click **Next**.



Data for the Near Target are displayed in **Results** and highlighted by a green background.



Results

Target	Vertical	Horizontal
Near Target	.0190	.0053
Far Target		
Set Point		

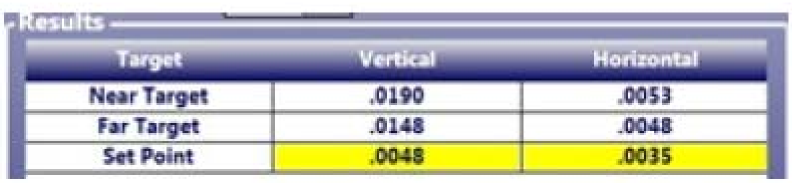
5. Follow the on-screen instructions to take data for the Far Target and click **Next**.

Data for the Far Target are displayed in **Results** and highlighted by a green background.

Results

Target	Vertical	Horizontal
Near Target	.0190	.0053
Far Target	.0148	.0048

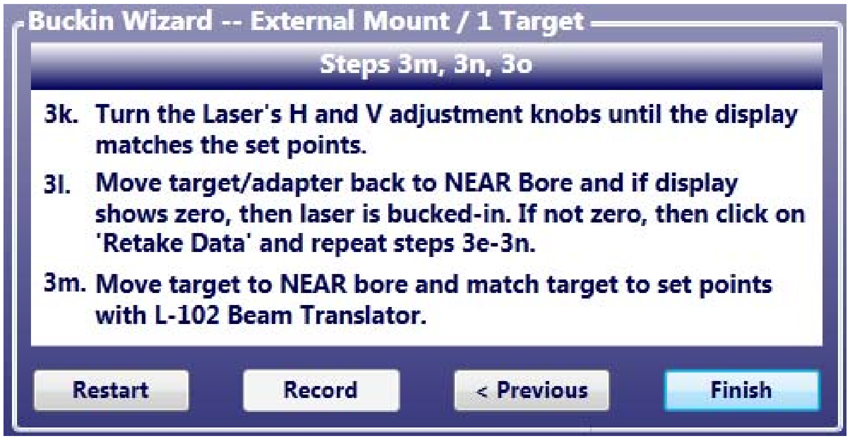
6. After clicking **Next**, the Laser Set Points are calculated and highlighted in yellow in **Results**.



Results

Target	Vertical	Horizontal
Near Target	.0190	.0053
Far Target	.0148	.0048
Set Point	.0048	.0035

7. Follow the on-screen instructions to steer the laser beam so that the display matches the Set Points.



8. If the display does not show zero after moving the target back to the Near Bore, repeat the above steps until the target displays zero in both the near and far bore locations.

Step 4: Record Data

Once the laser is bucked in, begin taking data.

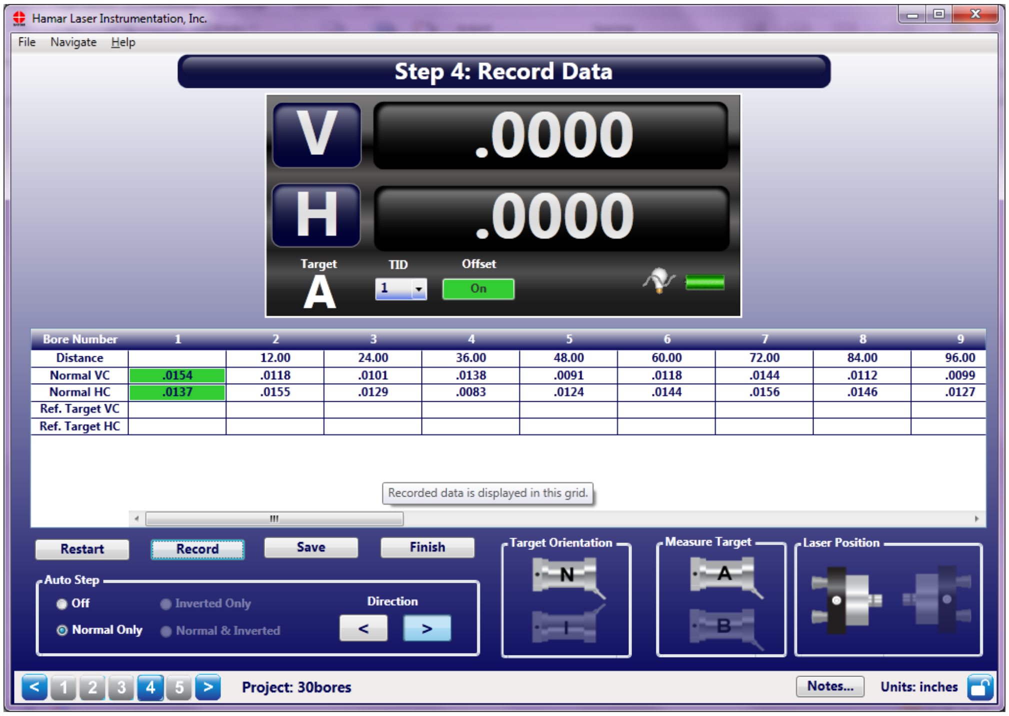
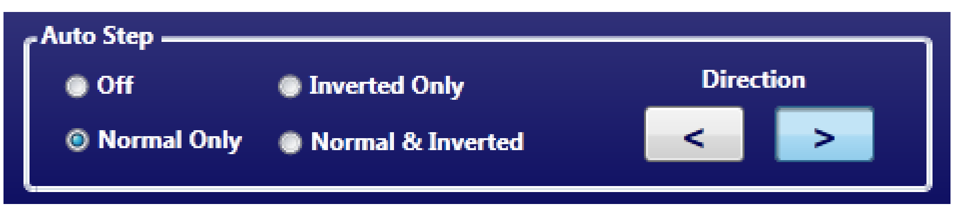


Figure 17 – *Record Data screen*

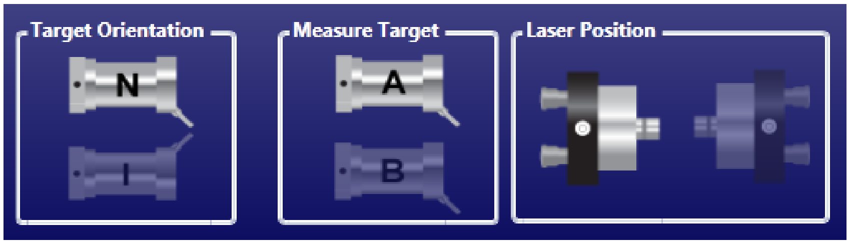
Auto Step – Auto Step automatically moves from one point to the next, either in NORMal Mode, INverted Mode, or in both modes. Check the box marked Auto Step to toggle the Auto Step feature on and off. When Auto Step is ON, the cursor automatically advances to the next position when data is recorded. When Auto Step is OFF, data records at the same position and overwrites the previous data recording. Disabling Auto Step allows the user to move the target to a point where data has previously been recorded, select that point on the plot and retake the reading.



Direction – To change the direction to record data, click the left or right **Direction** arrow in the Auto Step area of the screen.

The **Target Orientation**, **Measure Target** and **Laser Position** icons illustate the settings being used by the software.

- When clicking on a NORMal data point in the table, **Target Orientation** displays an **N**.
- When clicking on an INverted data point, **Target Orientation** displays an **I**.



Taking Data in Step 4

1. Select the **Auto Step** method to use in the **Auto Step** box at the bottom of the screen.
2. Insert the target/adapter into the first bore. Click **Record** or press the spacebar to record the data point.
3. Move target/adapter into the second bore and repeat Step 2 to record data.
4. Continue until all the data has been recorded.
   Note: *To retake a data point, move the target to the desired bore location and click on the matching data point in the table. Click* ***Record*** *or press the spacebar to re-record the data. A popup window displays, asking for confirmation before overwriting the data for that point.*

Step 5: Results

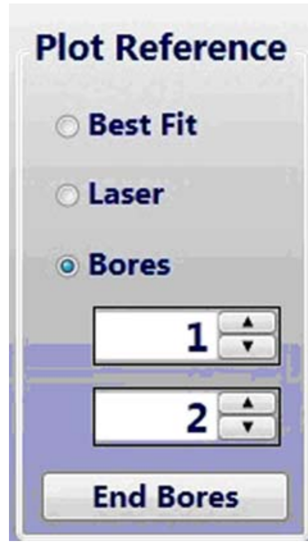
Figure 18 – *Bore Plot*

Figure 18 shows the final results of a bore plot. The top plot shows the Side View/Vertical axis data view and the bottom plot shows the Top View/Horizontal axis data. The red dotted line between points indicates that the difference between the two points is *outside* of the Bore-to-Bore tolerance. The solid blue line indicates the difference between the two points is *within* Bore-to-Bore tolerance. The black dashed line is the Best-Fit line for the data.

The **Plot Reference** can be changed to reflect the data as follows:

Best Fit – Shows the misalignment of the bores relative to the Best-Fit line rather than to the laser beam. To calculate the Best-Fit line, a least-squares, best-fit algorithm is used to find a line that "best fits" the raw data. It is especially useful because it removes any excess error in the data from the laser beam not being perfectly aligned to the end bores. It also makes the laser setup faster since the laser beam does not have to be exactly centered in the bore to get accurate straightness measurements. When **Best Fit** is selected as a reference, the data is rectified to be relative to the Best-Fit Line (the Best-Fit line becomes the X axis) and the data is plotted relative to the Best-Fit Line (the X axis becomes the Best-Fit line). Any data points outside the gray area are out of overall tolerance relative to the Best-Fit line.

Laser – Shows the misalignment of the bores relative to the laser beam. A dashed black line indicates the Best-Fit line. When **Laser** is selected as a reference, the Overall Tolerance is always displayed +/- around zero as a gray shaded area. Any data points outside the gray area indicate that the data set is out of tolerance relative to the laser buck-in.



Bores – Shows the misalignment of the bores relative to the selected bore numbers. This view makes the designated bore numbers the *zero* point and plots the positions of the remaining bores in relation to selected bore numbers. It also shows the Best-Fit Line of how much overall slope there is in the bore data relative to the selected bores. When **Bores** is selected as a reference, it rectifies the data to use the two bores chosen as the reference. The tolerance band stays around the X axis and any data points outside the gray area are out of overall tolerance relative to the bores selected.

End Bores – Shows the misalignment of the bores relative to the end bores. This view makes the end bores the *zero* point, and plots the positions of the remaining bores in relation to the end bores. It also shows the Best-Fit Line of how much overall slope there is in the bore data relative to the end bores.

Show Features

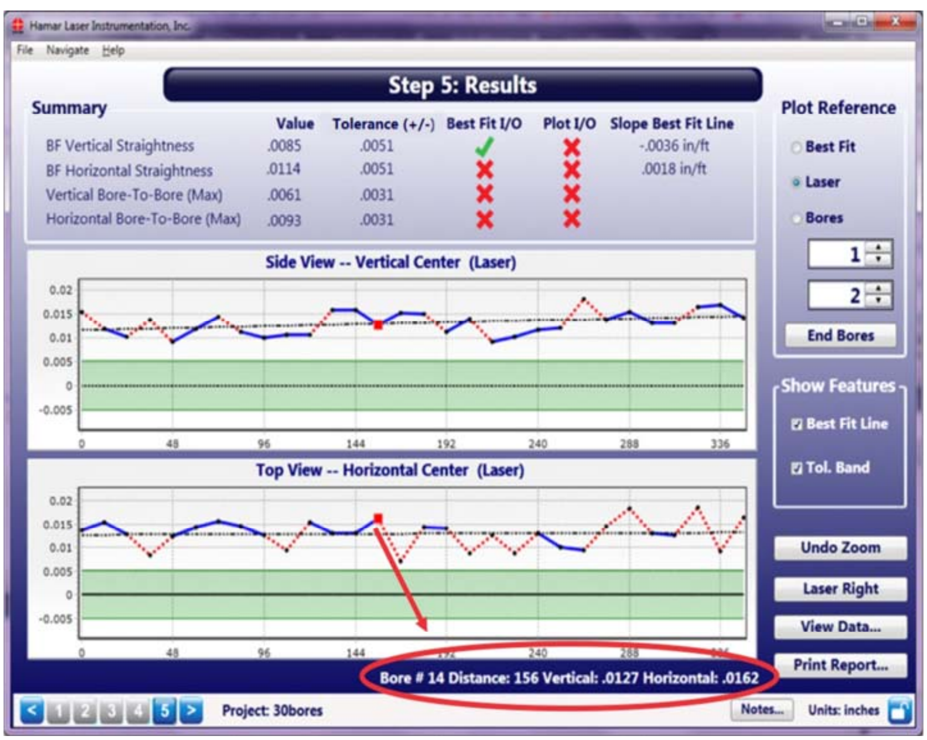
To show or hide a descriptive line on the plot, either check or uncheck the appropriate box.

Best Fit Line – The Best Fit line is shown on the plot as a dashed black line. Click on the check box to toggle the Best-Fit line on/off.

Red Dotted Line – A red dotted line indicates out of Bore-to-Bore tolerance. This should not be affected by the selected reference.

Tol. Band – Click to toggle the Overall Tolerance Bands **ON** or **OFF**.

Hover the mouse cursor over any *data point* to view the data for that point. A red square displays on the graph to indicate which point is selected and the cumulative distance to the data point/bore displays in the lower right corner of the plot area.



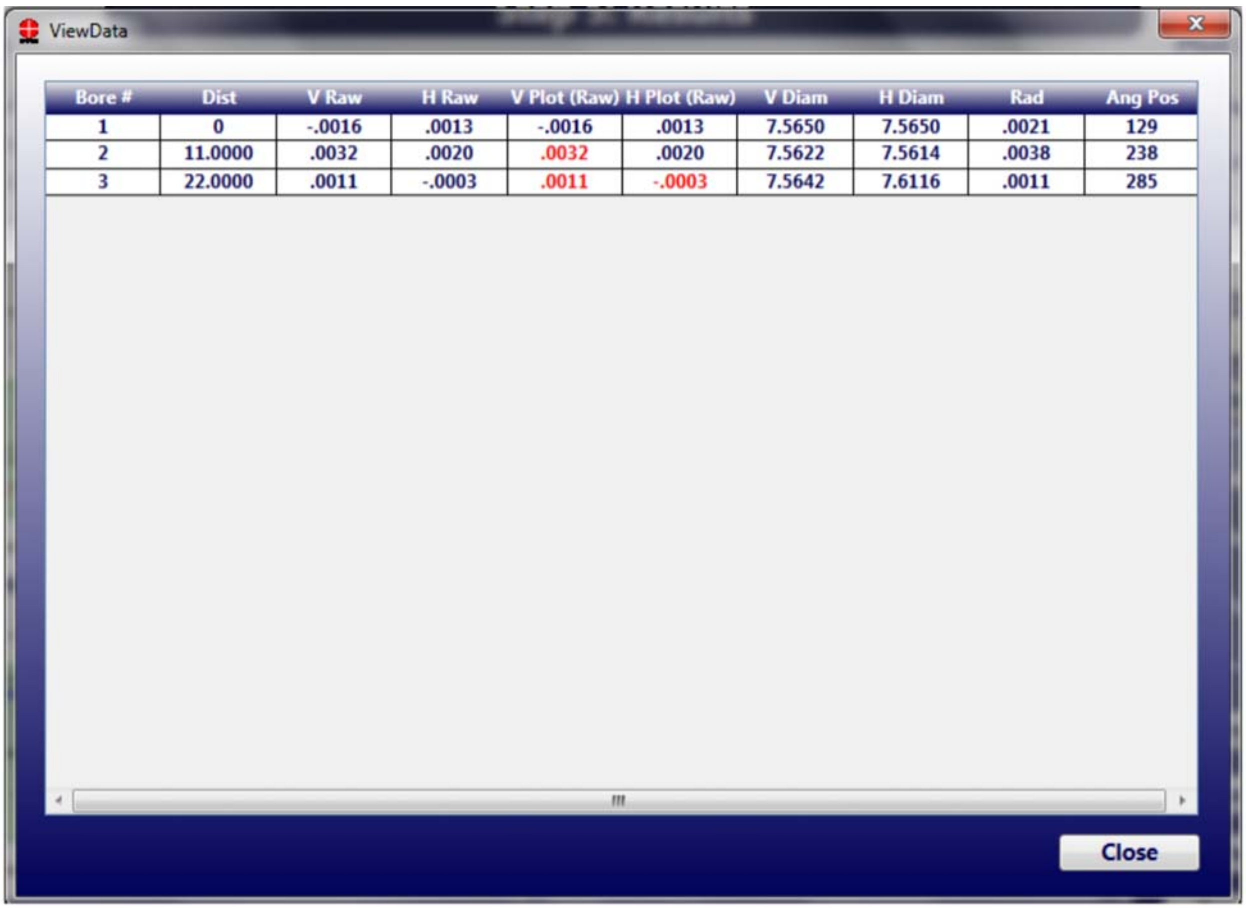
Other Features of the Bore Plot Screen

AutoScale/Zoom
To increase or decrease the scale of a specific plot window, hold the cursor over the area, hold left mouse button down and draw a box of the area you want to zoom.

Undo Zoom
Click **Undo Zoom,** to remove the zoomed in area**.** This is useful when there are more than15 bores.

Laser Right/Left – To change the orientation of the laser beam on the screen to reflect the physical setup, select **Laser Right/Left**. This flips the data back and forth to reflect the orientation.

View Data
Click to view the recorded data and analysis that will be printed in the report.



Bore #	Dist	V Raw	H Raw	V Plot (Raw)	H Plot (Raw)	V Diam	H Diam	Rad	Ang Pos
1	0	-.0016	.0013	-.0016	.0013	7.5650	7.5650	.0021	129
2	11.0000	.0032	.0020	.0032	.0020	7.5622	7.5614	.0038	238
3	22.0000	.0011	-.0003	.0011	-.0003	7.5642	7.6116	.0011	285

Generating a Report

Click **Print Report** to print the report to a selected printer (see Figure 19).

A report may also be saved as a .pdf file, however it is necessary to have software such as Adobe Acrobat installed on your computer in order to generate this type of file. Click **Print Report** and select your .pdf generating software as the printer name. You will be asked to specify a file name for the report (see Figure 20).

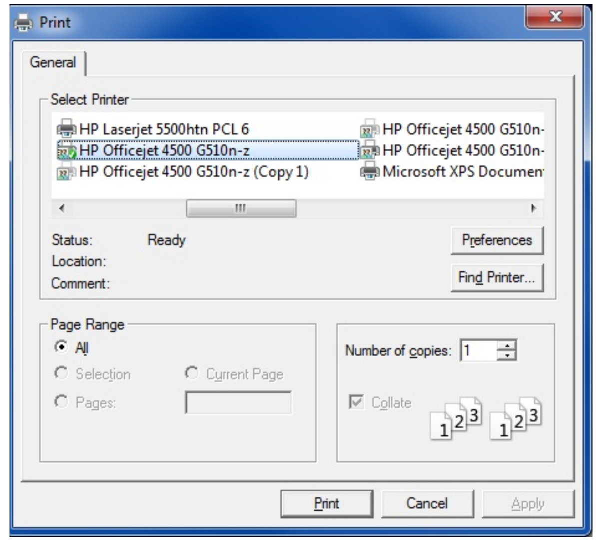


Figure 19 – *Printing a report to a printer*

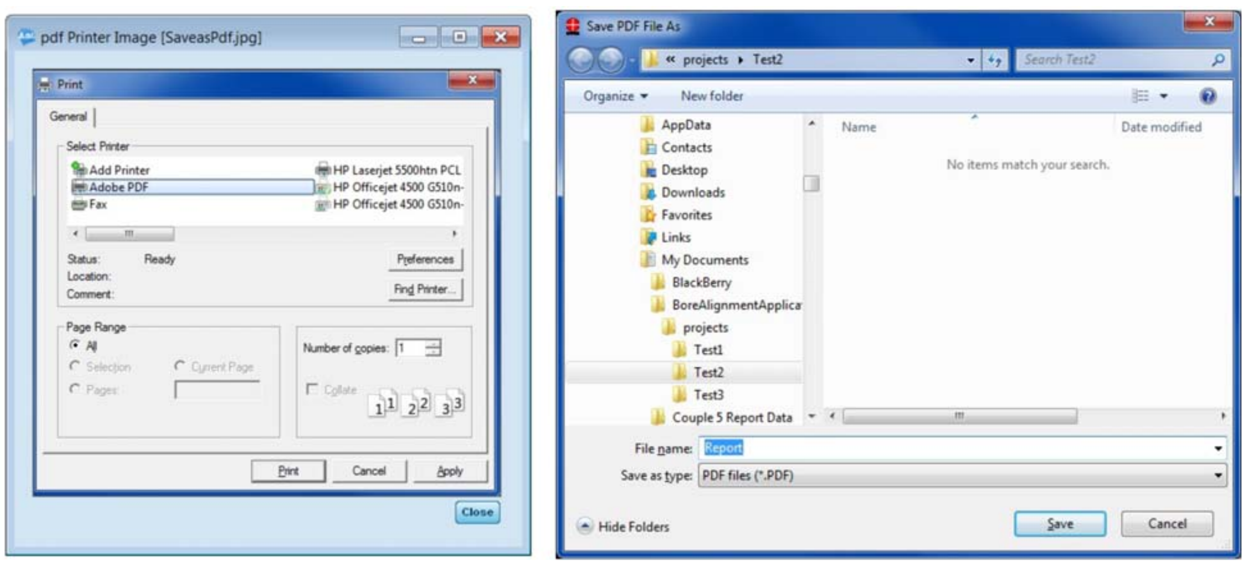


Figure 20 – *Saving a report as a .pdf file*

The following page shows a sample 4-page report generated by the Bore9 software.

Project: 30bores

Report Issued By

Company Name:
Address:
City, State Zip:
Phone/FAX:
Company EMail:

Machine Information

Factory Name:
Machine Information:
Notes:

Alignment Results

Alignment Check	Value	Tolerance	In/Out
Vertical Straightness	.0084	0	
Horizontal Straightness	.0113	0	
Vertical Bore To Bore	.0073	0	
Horizontal Bore To Bore	.0073	0	

Setup Information

Number of Bores	30
Distance between bores	12.00
Units	inches
Overall Tolerance	0
Bore to Bore Tolerance	0
Target / Interface	
Serial Number	
Calibration Date	1/1/0001

Result Graphs

Alignment Data

Bore #	Dist	V Raw	H Raw	V Plot	H Plot	Rad	Ang Pos
1	0	.0154	.0137	.0037	.0009	.0039	255
2	12	.0118	.0155	9.6907	.0027	.0027	182
3	24	.0101	.0129	.0017	.0001	.0017	265
4	36	.0138	.0083	.0018	.0044	.0048	203
5	48	.0091	.0124	.0029	.0003	.0029	263
6	60	.0118	.0144	.0003	.0016	.0016	191
7	72	.0144	.0156	.0021	.0027	.0035	218
8	84	.0112	.0146	.0011	.0017	.0020	212
9	96	.0099	.0127	.0025	.0001	.0025	267
10	108	.0106	.0095	.0019	.0033	.0038	210
11	120	.0106	.0153	-.0020	.0024	.0031	220
12	132	.0158	.0130	.0030	.0001	.0030	268
13	144	.0158	.0131	.0029	.0001	.0029	266
14	156	.0127	.0162	.0002	.0032	.0032	184
15	168	.0152	.0070	.0021	.0059	.0063	200
16	180	.0150	.0143	.0018	.0013	.0023	234
17	192	.0112	.0141	.0020	.0011	.0023	241
18	204	.0139	.0088	.0005	.0041	.0042	188
19	216	.0092	.0126	.0042	.0003	.0042	265
20	228	.0102	.0088	.0033	.0042	.0053	218
21	240	.0117	.0130	.0019	1.1064	.0019	269
22	252	.0120	.0101	.0017	.0029	.0034	210
23	264	.0181	.0094	.0042	.0036	.0056	229
24	276	.0137	.0146	.0002	.0015	.0015	188
25	288	.0153	.0184	.0012	.0053	.0054	194

Alignment Data (Continued)

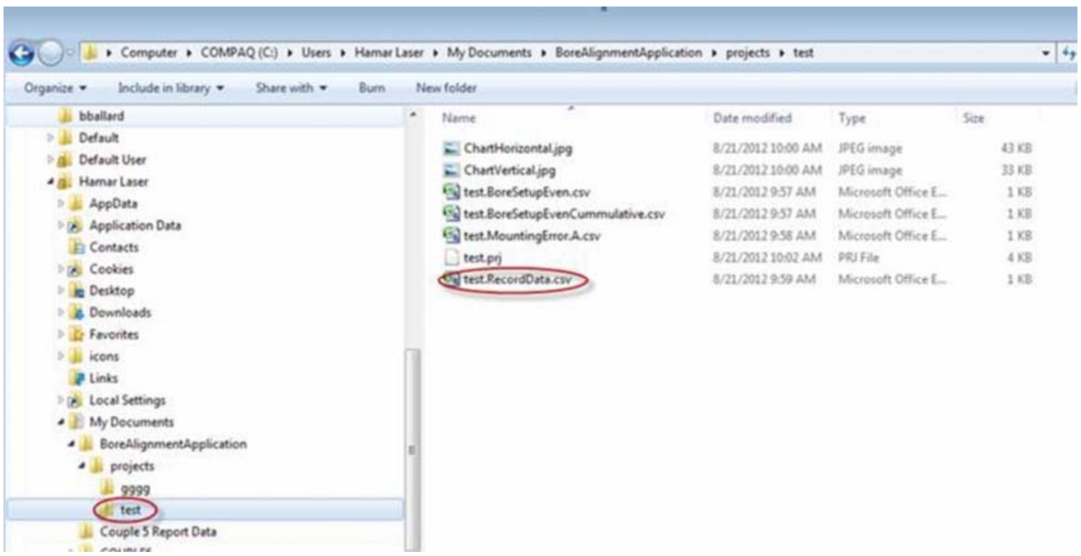
Bore #	Dist	V Raw	H Raw	V Plot	H Plot	Rad	Ang Pos
26	300	.0130	.0130	.0011	.0001	.0039	255
27	312	.0130	.0126	-.0012	.0005	.0027	182
28	324	.0164	.0186	.0020	.0054	.0017	265
29	336	.0168	.0093	.0023	.0038	.0048	203
30	348	.0141	.0165	.0004	.0033	.0029	263

Exporting Alignment Data to Excel Spreadsheets

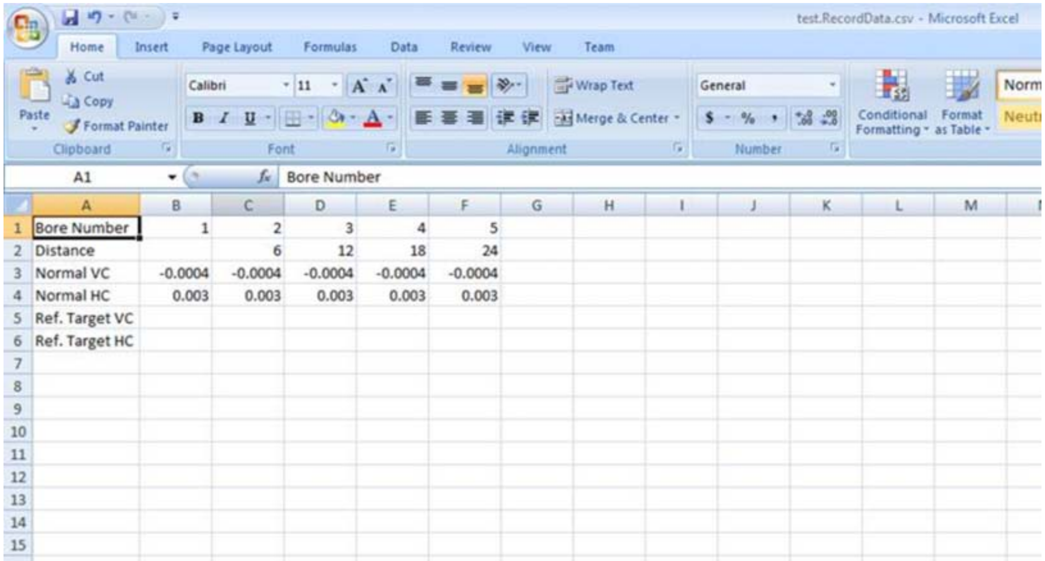
To export alignment data to an Excel spreadsheet for further analysis, do the following:

1. Locate the Project Folder where your data is saved.
   Note: *When data is saved, a project folder with the name you entered is automatically created. For example, if you save a project named* **Test**, *a folder is created called* **Test** *that is located in My Documents/Bore Alignment Application/Projects. This folder includes several files as well as the alignment data for the saved file.*

2. Open the folder and locate the file with the same name as the folder name, followed by *RecordData*. For example, for the **Test** project name, the Excel data filename will be **test.recordData.csv**. Also created is a file called (*projectname*)**.results.csv** file, which contains additional data not provided in the (*projectname*)**.recordData.csv** file.



3. Assuming you have Microsoft Excel installed, double-click the file name. This automatically opens Excel and displays the data.



	B	C	D	E	F
Bore Number	1	2	3	4	5
Distance		6	12	18	24
Normal VC	-0.0004	-0.0004	-0.0004	-0.0004	-0.0004
Normal HC	0.003	0.003	0.003	0.003	0.003
Ref. Target VC					
Ref. Target HC					

Where:

Distance = distance between each set of bores.
Normal VC = the Vertical-axis misalignment data relative to the reference points chosen (Best Fit, Laser, Bores, End Bores).
Normal HC = the Horizontal-axis misalignment data relative to the reference points chosen (Best Fit, Laser, Bores, End Bores).
Ref. Target VC = the Vertical-axis misalignment data of the reference target taken at the same time as the bore misalignment data.
Ref. Target HC = the Horizontal-axis misalignment data of the reference target taken at the same time as the bore misalignment data.
Inverted VC = the inverted Vertical-axis misalignment data (if selected in Preferences).
Inverted HC = the inverted Horizontal-axis misalignment data (if selected in Preferences).

Appendix A - The NORMIN Procedure

The NORMIN method was developed by Hamar Laser Instruments as a way of compensating for laser or target mounting errors in bore or spindle work. The word is a contraction of “NORMal-INverted,” which briefly describes the method. It is quite similar to the four clock readings taken with dial indicators, but uses a laser and a target instead. The NORMIN method is used in conjunction with simple fixtures and targets that allow inexpensive, precision measurement. The target/fixture is set in the bore or spindle in the NORMal position (cable down) and the readings are recorded. Then the target/fixture is rotated 180 degrees to the INverted (cable up) position, and a second set of readings is obtained. The two sets of readings cancel out centering errors and provide a very accurate result.

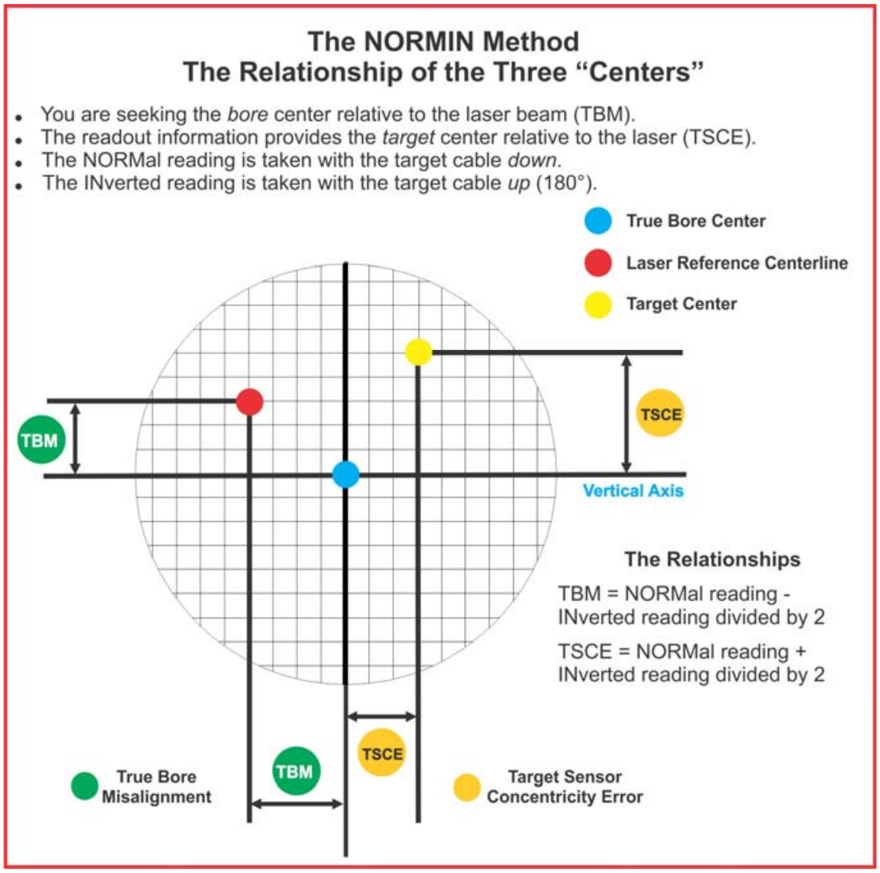


Figure 21 -- *Three centers of bore alignment*

There are three centers involved in bore alignments: the True Bore Center, the Target Center, and the Laser Reference Centerline. If mounting fixtures were perfect, the Target Center would be located at the True Bore Center, and if perfectly aligned, the True Bore Center would be located at the laser beam center. In reality, however, they seldom line up. An example of the three centers with respect to one another is shown in Figure 21.

Two relationships can be calculated from these three centers and two sets of NORMIN readings: the Target Sensor Concentricity Error (TSCE) and the True Bore Misalignment (TBM). The True Bore Misalignment (TBM) is used when it is desirable to know the true bore centerline position relative to the laser beam center without fixture errors. Usually, the laser beam center is where a bore center *should* be located, and the TBM shows its *actual* location. The Target Sensor Concentricity Error (TSCE) is used if the operator wants to place the laser beam center exactly in the middle of a bore.

The general rule is: buck in to the TSCE and measure the TBM.

The readout always shows the displacement between the Target Center and the Laser Beam Center. When the Target Center is not on the True Bore Center, the numbers and the signs on the readout will change when the target is rotated because the Target Center is moved to a different location in relationship to the laser beam.

Figure 22 represents the target in the NORMal position, with the cable *down*. If each square represents .001", the Target Center is .002" higher than the Laser Beam Center (+.002") and is .007" to the right of the Laser Beam Center (+.007").

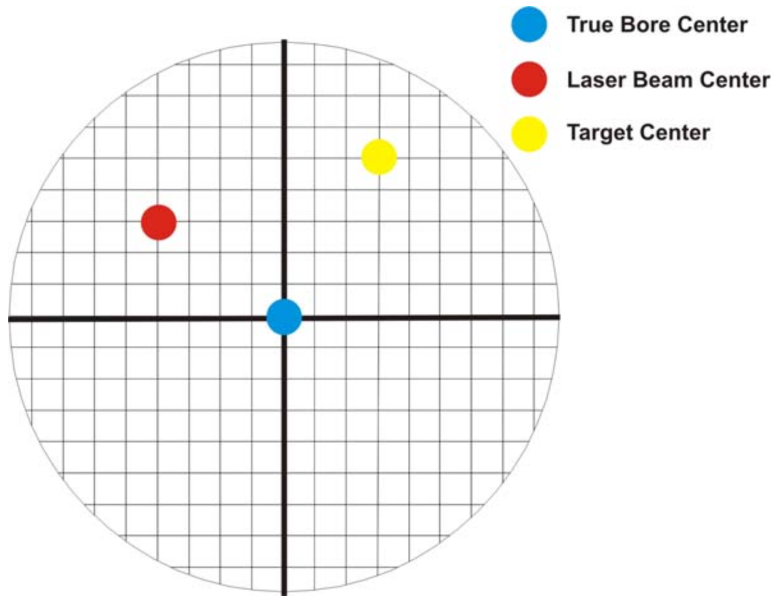


Figure 22 – *Target in the NORMal position*

Figure 23 represents the target in the INverted position, with the cable *up*. When the target is rotated, the *signs* on the readout are also rotated. Therefore, although the Target Center appears to be to the right of and lower than the Laser Beam Center in Figure 23, the vertical readings will be positive and the horizontal readings will be negative. When the vertical TCE is calculated, (NORMal+INverted divided by 2) the Target Center is .004" higher and .003" to the right of the True Bore Center in the NORMal position.

The table below shows the calculation of the vertical and horizontal TSCE values.

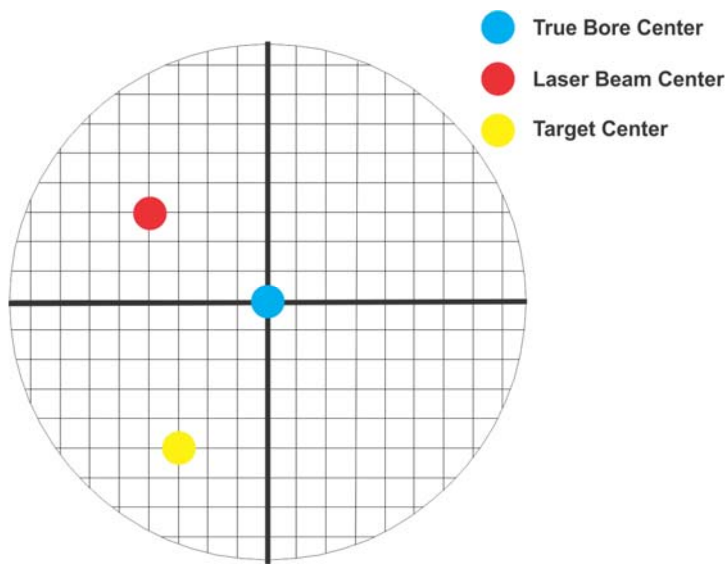


Figure 23 – *Target in the INverted position*

NORMal Vertical Reading	+.002"		NORMal Horizontal Reading	+.007"
INverted Vertical Reading	+.008"		INverted Horizontal Reading	-.001"
Total	+.010"		Total	+.006"
Divide by 2 = **Vertical TSCE**	**+.005"**		Divide by 2 = **Horizontal TSCE**	**+.003"**

If you place the Laser Beam Center exactly on the True Bore Center with the target in the NORMal position, the readings will show Vertical +.005" and Horizontal +.003".

Appendix B – The A-910 Radio Transceiver/Hub

Front Panel Features

1. **Power ON indicator and Low Battery indicator**
2. **Internal backup battery charging indicator and USB LINK ESTABLISHED indicator**
3. **TX indicator:** blinks when device is transmitting data to the target(s)
4. **RX indicator:** blinks when the device is receiving data from targets or other transceivers.
5. **System ID setting switch:** set to the same number as the R-1307's CH (Channel) number.

Figure 24 – *The A-910 Radio Transceiver/Hub FRONT PANEL*

Rear Panel Features

1. **Not used**
2. **USB/Data I/O Port**
3. **Power Switch**
4. **External power supply:** required only for computers that cannot provide adequate power (5V, 400 mA) through the USB port.
   Note: *When using the USB Extender™ cable extension kit, plug the A-910-2.4 into an A/C power supply.*
5. **Antenna**

Figure 25 – *The A-910 Radio Transceiver/Hub REAR PANEL*

See Appendix C for radio specification details.

MODEL NUMBER	PRIMARY FREQUENCY
A-910-900	***900 MHz***
A-910-2.4	***2.4 GHz***

Using the R-1307 with a Local Target and the A-910 Radio Transceiver

Setting the Target Network ID and System ID for the R-1307 Readout

To make the unit visible to all other radio-enabled devices, you must set the Target Network ID and the System ID for the readout.

1. **Set the Local Readout/Target Network ID**
   Press the MENU button until the *upper* display shows id .: nn (nn is also equal to the R-1037 number) and the matching Target number with the current Target ID (nn) blinking. Use the UP and DOWN arrow keys to set the Target ID.

   Press the MENU button again until the lower display shows id. : nn with the current Target ID (nn) blinking. Use the UP and DOWN arrow keys to set the Target ID to the same value as that of the upper display's Target ID.

2. **Set the System ID (Radio Channel)**
   Press the MENU button until the upper display shows ch .: nn, with the current System ID (nn) blinking. Use the UP and DOWN arrow keys to set the System ID.

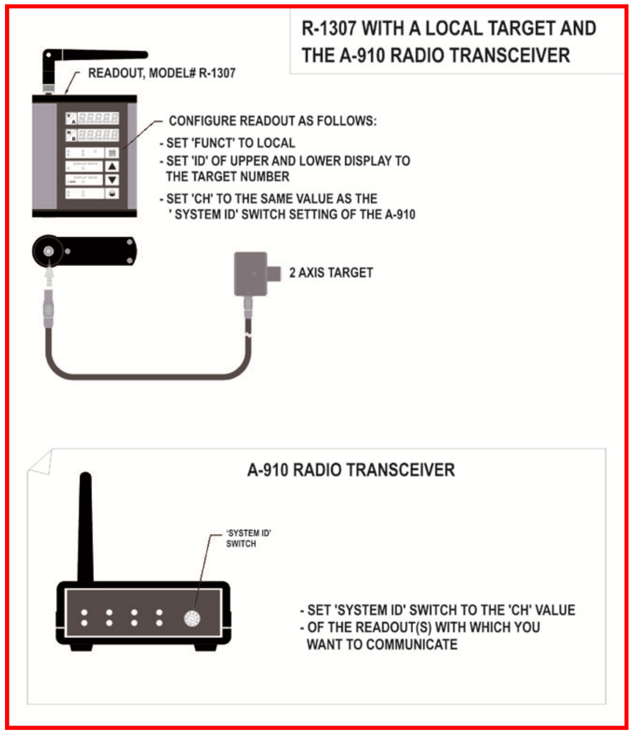


Figure 26 -- *R-1307 with Local Target and A-910 Radio Transceiver*

   Note that **nn** must be set to the same number as the channel switch setting of the A-910 radio transceiver (see Figure 24, #5).

Miscellaneous Display Messages

-HLI- r 1_00	Startup Message. Lower Display shows firmware Revision Number.
. . .	3 moving dots. Wireless target is not responding to a polling request from Readout. Check ID and Channel settings. Check Target(s).
- - -	3 dashes. Target detected but the laser is not on target. Check laser.
ch_:no rAd io	Radio channel cannot be selected because no Radio is present or detected. Standard message for R-1307C. For Models R-1307 or R-1307W, this message indicates a fault in the radio module.
FAuLt PSd	Indicates a problem with the connection to the Local Target's Position Sensing Device (PSD). Check plugs and cable(s).
tGt_n UncAL	Target 'n' descriptor does not contain target calibration data.

See Appendix D on Page 54 for the complete R-1307 menu.

Appendix C - Agency Certifications

Agency Certifications for the 2.4 GHz Radio Transceiver

FCC (United States of America) Certification

Contains FCC ID: OUR-24XSTREAM
The enclosed device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference and (2) this device must accept any interference received, including interference that may cause undesired operation.

⚠ RF EXPOSURE WARNING: This equipment is approved only for mobile and base station transmitting devices, separation distances of (i) 20 centimeters or more for antennas with gains < 6 dBi or (ii) 2 meters or more for antennas with gains ≥ 6 dBi should be maintained between the antenna of this device and nearby persons during operation. To ensure compliance, operation at distances closer than this is not recommended

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IC (Industry Canada) Certification

Contains Model 24XStream Radio (2.4 GHz), IC: 4214A 12008
Complies with IC ICES-003

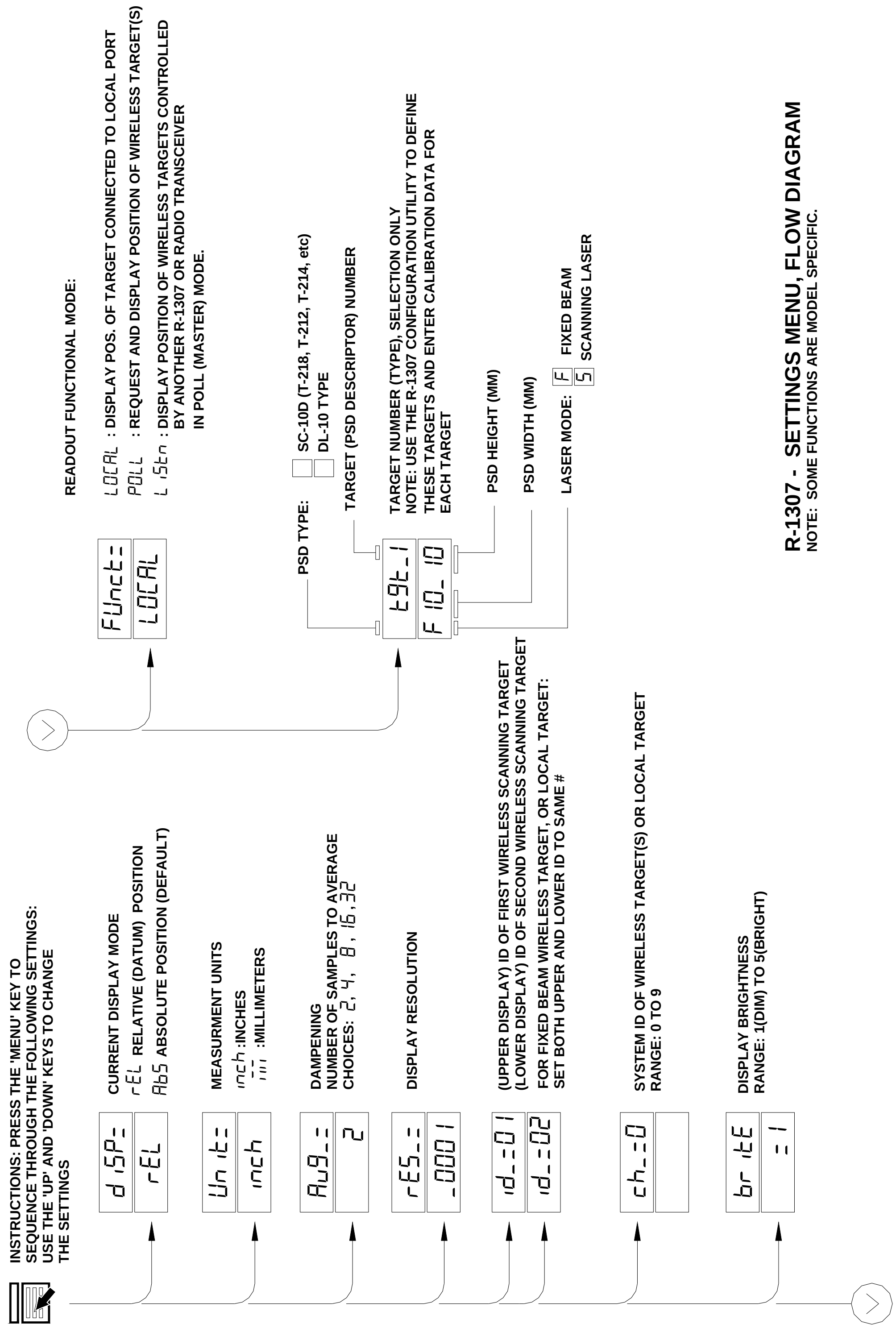
Complies with ETSI. *France – France imposes restrictions on the 2.4 GHz band. Go to www.art-telecom.Fr or contact MaxStream♦ for more information. Norway – Norway prohibits operation near Ny-Alesund in Svalbard. More information can be found at the Norway Posts and Telecommunications site (www.npt.no).*

Since the 2.4 GHz band is not harmonized throughout Europe, other restrictions may apply to your country.

Technical Data:
• OEM radio transceiver, model number: 24XStream
• Frequency Band: 2400.0 – 2483.5 MHz
• Modulation: Frequency Shift Keying
• Channel Spacing: 400 kHz
• ITU Classification: 400KF1D
• Output Power: 100 mW EIRP max.
• Notified Body Number: 0891

♦ The radio Transceiver contained in the A-1519/A-1520 Type II Universal Wireless Targets is manufactured by MaxStream®. For more information pertaining exclusively to the Radio Transceiver please contact MaxStream at 1.801.765.9885 or visit their web site: http://www.maxstream.net

Appendix D – The R-1307 Menu



Appendix E – Using the Zigbee® Radio Utility

Pre-installing the Common USB Port Driver (A-910-2.4ZB)

This driver is required for the A-910-2.4ZB Transceiver and to communicate with targets via the computer's USB port. The driver creates a virtual COM Port that is recognized by the applications as a standard serial port.

Note: *You must pre-install this driver prior to connecting the device(s) to the computer through the USB port.*

Installing the Driver

1. Insert the A-910-2.4ZB Radio Programmer CD in the CD ROM drive.
2. Select **My Computer**, locate the CD ROM icon and click to open it.
3. Select the USB Drivers folder.
4. Select the correct Operating System installed on your computer (Windows 2000, Windows XP, etc.) and open the folder.
5. Locate the **CP210x_VCP** icon and click to initiate the installation process. The **Install Driver** dialog box displays.
6. Click **Browse** to select an installation folder different from the default folder (optional).
7. Click **Install** to continue. Once the installation is complete, the **Installation Successful** message displays (see Figure 27).

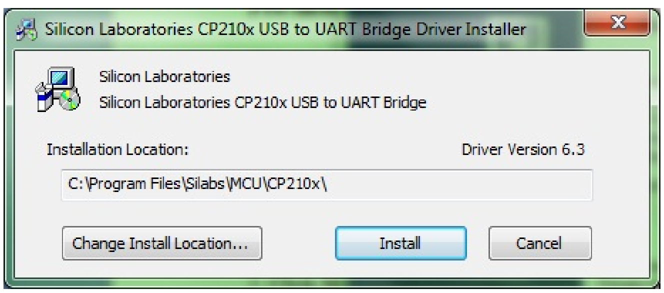


Figure 27 - *USB Common Driver Install*

Installing the A-910 Utility Software

1. Insert the A-910-2.4ZB Radio Programmer CD in the CD ROM drive.
2. Select **My Computer**, locate the CD ROM icon and click to open it.
3. Locate the **Setup** icon and click to initiate the installation process. Click **NEXT** to continue.
4. Click **Browse** to select an installation folder different from the default folder (optional).
5. Click **Next** to continue. Once the installation is complete, the **Installation Complete** message displays. Select **Close.**

Configuring the Hardware and Utility Settings

1. Insert the A-910 ZB dongle into any unused USB Port (see Figure 28). The computer should automatically assign a COM port number to the dongle.
2. Start the A-910 Utility Software. The software should display the COM port assigned to the Zigbee Dongle (see Figure 29). If the utility does not automatically detect the COM port, it must be manually selected (see **Manually Selecting a COM Port** on Page 57).
3. The Target System ID or R-1307 CH (channel) is the number associated with the A-1519/1520 targets or R-1307 Readout. If using both the A-1519/1520 targets and an R-1307 Readout, both need to be set to the same system ID and channel (see Figure 30).

Figure 28 – *A-910 Zigbee Dongle*

Figure 29 – *A-910 Utility showing the COM Port, System ID and Channel settings*

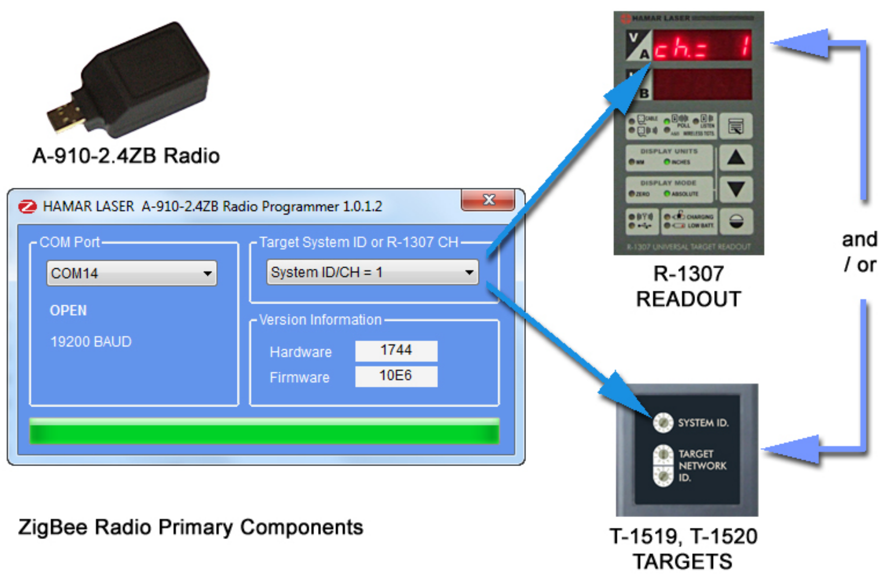


Figure 30 – *System ID Setup*

Manually Selecting the COM Port

The A-910 Utility should automatically detect the COM Port upon startup. If not, use the following steps to locate the correct COM Port.

Windows XP

1. Right-click My Computer.
2. Click **Properties** and then select the **Hardware** tab.
3. Click **Device Manager**.

Windows 7

1. Click the **Start** button and select **Control Panel**.
2. Click the **System** icon.
3. In the **System** window, click on the Device Manager link located under the **System** heading.
4. In Device Manager, scroll down to **Ports.** Expand the listings under **Ports** to reveal all the ports installed.
5. Locate **SILICON LABS CP210x USB to UART Bridge (COM x)** (see Figure 31**).**
6. Note the COM Port listed and select that COM Port in the A-910 Zigbee Utility software using the drop-down arrow (see Figure 30).

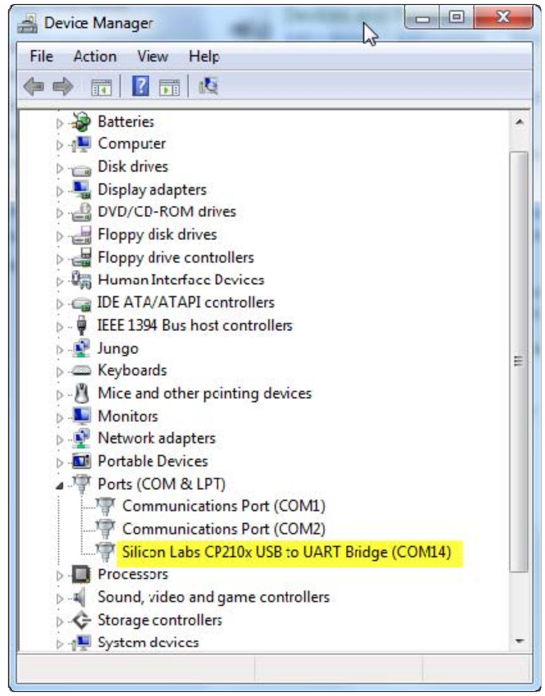


Figure 31 -- *Device Manager showing COM Port for A-910 Dongle*

Setting the Target System ID and Target Network ID

The System ID is a Radio Network Address that is used by the Radio Communications Protocol to filter unwanted data from other radio transceivers and targets using a different address. Only targets and radio transceivers that are set to a matching System ID can communicate with each other.

Because no two targets with the same System ID can transmit simultaneously, it is necessary for each target to be programmed to respond only when it is being addressed. The Target Network ID is the target address on the communications network. Under Host (computer) control, the radio transceiver transmits a message called a *polling request* that contains the Target Network ID of one specific target. All targets receive all polling requests, but only the target with a Network ID matching the ID contained in the polling message will reply (Transmit Data to the Host).

There are three rotary DIP switches located on the right side of the target, shown in Figure 32:

- The uppermost switch sets the System ID.
- The two lower switches are used to set the target network ID.

Figure 32 – *Unitarget ID Switch set to1*

Setting the System ID

Note: *Before selecting a System ID, ensure that it is not already in use by another system within the radio coverage area.*

Using a small screwdriver, rotate Switch 1 to align the arrowhead with the System ID number (0-9). Figure 32 shows the System ID switch set to 1.

Setting the Target Network ID and System ID for the R-1307 Readout

To make the unit visible to all other radio-enabled devices, you must set the Target Network ID and the System ID for the readout.

1. **Set the Local Readout/Target Network ID**
   Press the MENU button until the *upper* display shows id=nn (nn is also equal to the R-1307 number) and the matching target number with the current target ID (nn) blinking. Use the UP and DOWN arrow keys to set the Target ID.

   Press the MENU button again until the lower display shows id=nn, with the current target ID (nn) blinking. Use the UP and DOWN arrow keys to set the Target ID to the same value as that of the upper display's Target ID.

2. **Set the System ID (Radio Channel)**
   Press the MENU button until the upper display shows ch = nn, with the current System ID (nn) blinking. Use the UP and DOWN arrow keys to set the System ID.
   Note that **nn** must be set to the same number as the channel switch setting of the A-910 radio transceiver (see Figure 33).

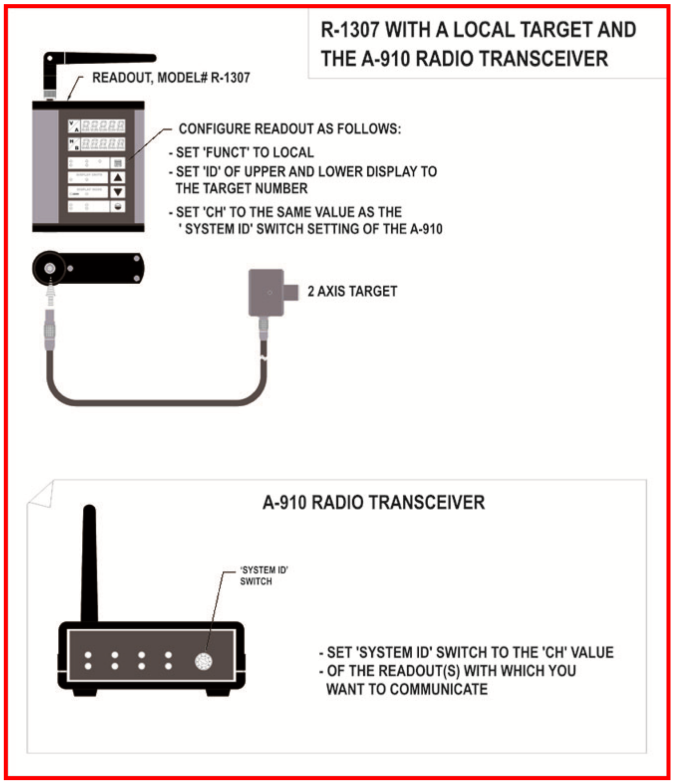


Figure 33– *R-1307 with Cabled (Local) Target and A-910 Radio Transceiver*

Miscellaneous Display Messages

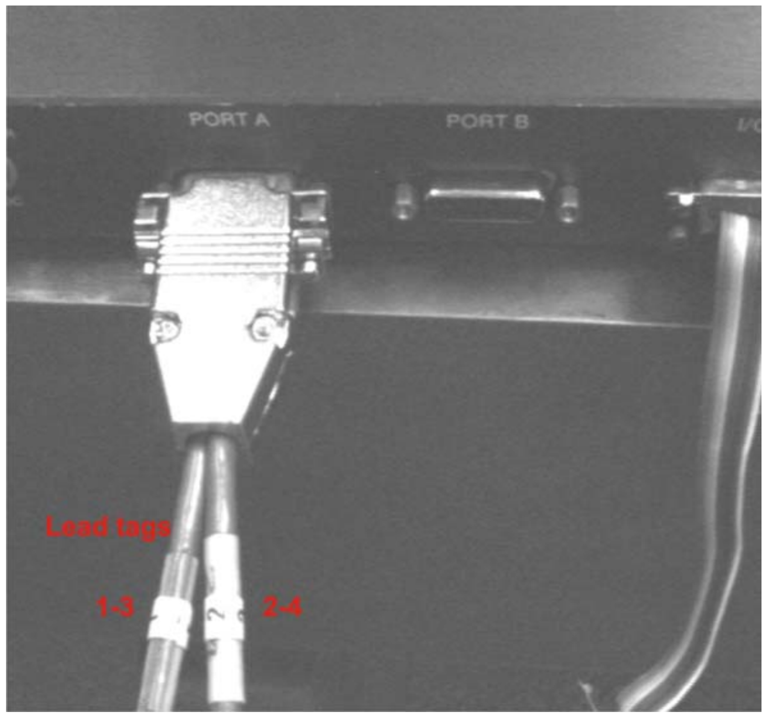
-HLI - r 1_00	Startup Message. Lower Display shows firmware Revision Number.
. . .	3 moving dots. Wireless target is not responding to a polling request from Readout. Check ID and Channel settings. Check Target(s).
- - -	3 dashes. Target detected but the laser is not on target. Check laser.
ch_=no rAd io	Radio channel cannot be selected because no Radio is present or detected. Standard message for R-1307C. For Models R-1307 or R-1307W, this message indicates a fault in the radio module.
FAuLt PSd	Indicates a problem with the connection to the Cabled (Local) Target's Position Sensing Device (PSD). Check plugs and cable(s).
tGt_n UncAL	Target 'n' descriptor does not contain target calibration data.

Appendix F – Using Discontinued Computer Interfaces

Connecting to the R-355D Computer Interface (Four-Axis Operation)

1. **Plug the target or targets directly into Port A or Port B of the R-355D Interface.**
   Port A is assigned either Channel 1 or Channel 2 in the software setup. Port B is assigned either Channel 3 or Channel 4.
2. Continue with Steps 4 and 5 on Page 62.

Connecting to the R-355D Computer Interface (Two-Axis Operation)



1. **Plug the T-237C Target Adapter Cable into Port A of the R-355D Interface**
   Two adapter cables may be used, (one on Port A and one on Port B) enabling the use of up to four targets. The locations of ports and switches on the R-355D Interface are shown in Figure 36.
2. **Plug the target into the T-237C Target Adapter Cable**
   Plug the target cable into one of the leads from the Target Adapter Cable. Each lead has a tag attached with either the numbers 1/3 or 2/4 (see Figure 34). Cables plugged into Port A are assigned either Channel 1 or 2 in the software setup, depending on the lead to which the target cable is connected. Cables plugged into Port B are assigned either Channel 3 or 4 in the software setup, depending on the lead to which the target cable is connected. See Figure 35 for a connection diagram. Note the Port designation for use in the software setup.
3. **Continue with Steps 4 and 5 on Page 62.**

Connecting to the R-355D Computer Interface (One-Axis Operation)

If you're using a target that is compatible with a scanning laser, the procedure is the same as that for two-axis operation except that a T-251 Target Scanner Preamp must be connected between each target and the T-237 Target Adapter (see Figure 35).

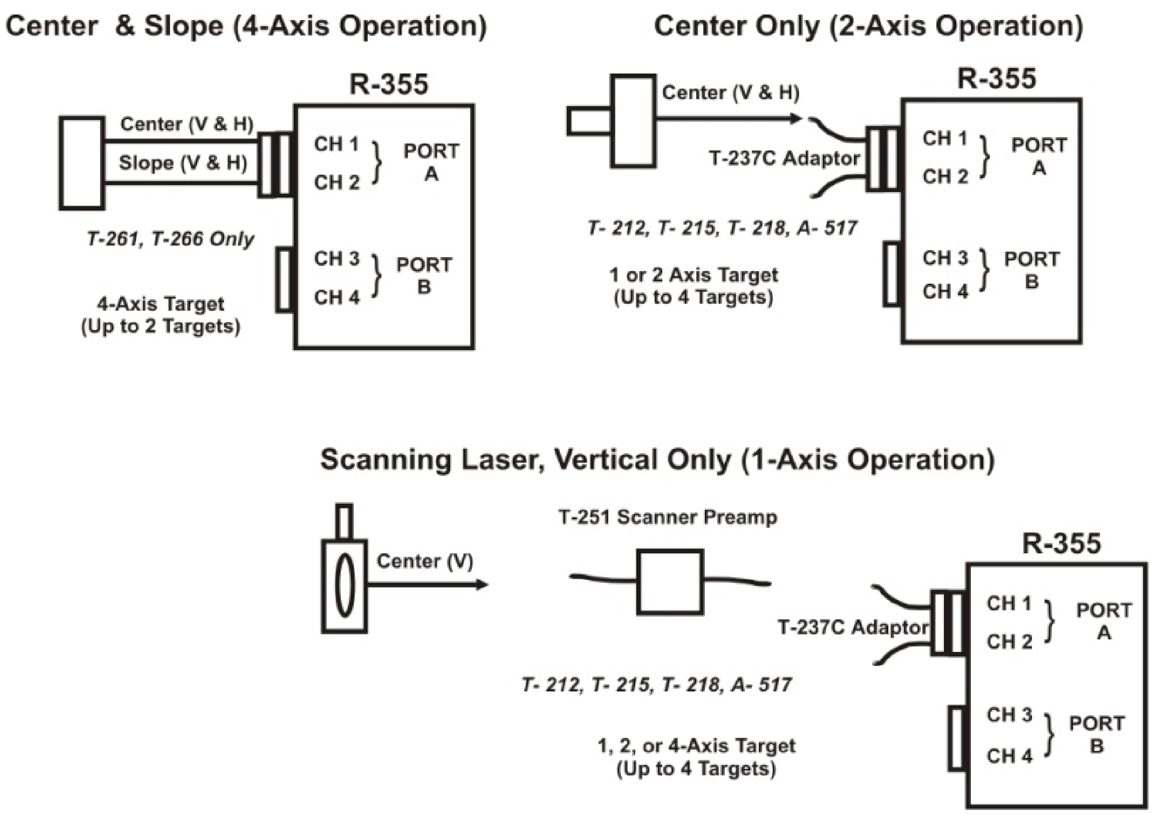
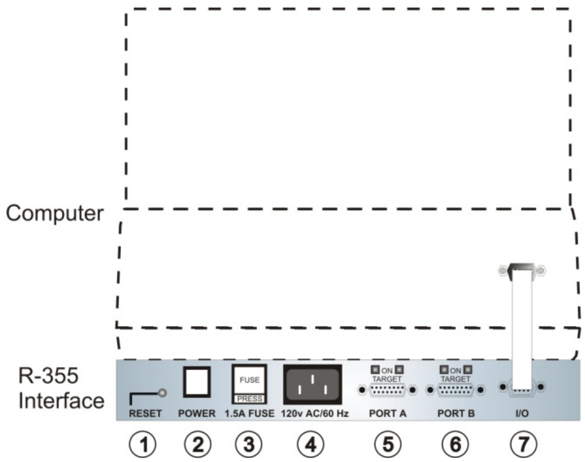


Figure 35 – *Connecting to the R-355D Computer Interface*

4. **Connect the R-355D Interface to the computer.**
Connect the interface to the computer serial port using the special small ribbon cable provided. The connector for the cable is located on the back of the R-355D Interface (see Figure 36).



1. Reset Button*
2. Power Pushbutton
3. Fuse
4. Power Cord Receptacle
5. Port A (Target Port)
6. Port B (Target Port)
7. Interface to Computer Serial Port

Figure 36 – *R-355D Computer Interface, Rear View*

5. **Turn on the R-355D Interface and the computer.**
Connect the power cord to the interface and press the Power pushbutton. Turn on the computer.

Appendix G – Converting X-Y Coordinates to Polar Coordinates in Alignment Reports

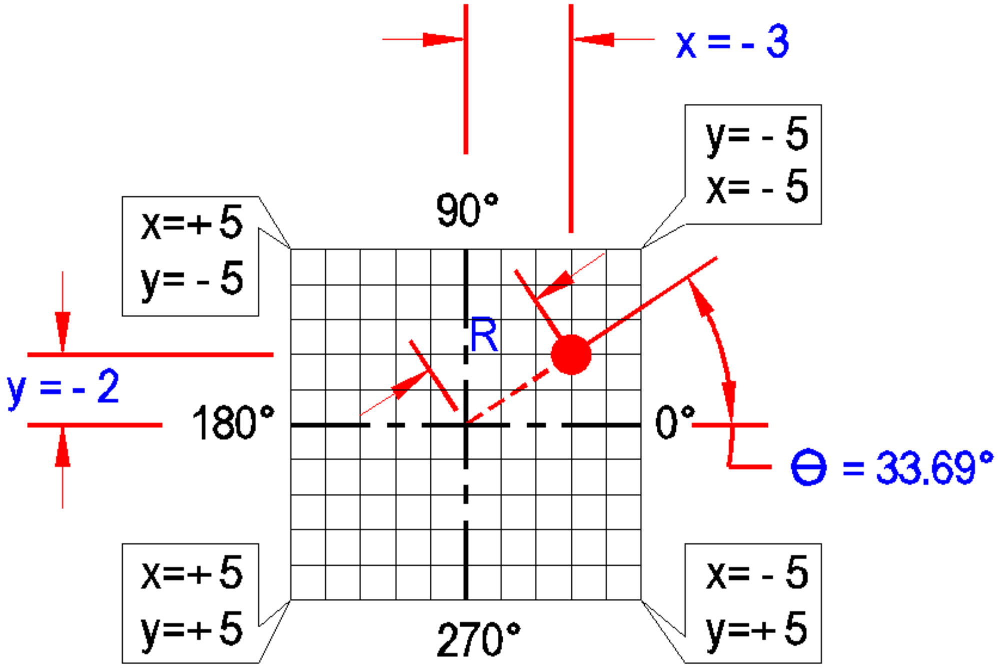


Figure 37 – *Corner position coordinates*

Figure 37 illustrates the corner position coordinates, as if the laser beam was located at the four respective corners. Also shown is an example of a laser beam located in the upper right quadrant of the PSD. The beam rotation angle is displayed in standard polar coordinates, as shown in Figure 38 (zero degrees at three o'clock and counter-clockwise rotation).

Note that Y = Vertical Position and X = Horizontal Position. Hamar lasers position readings are not in Cartesian coordinates (i.e. above center positive, below center negative, right of center positive, left of center negative). For that reason, the signs of both the X and Y position values used in the ATAN2 function must be inverted.

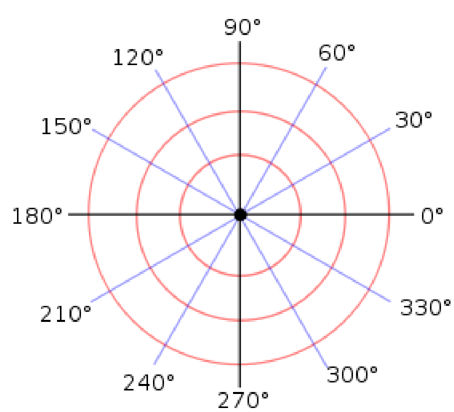


Figure 38 – *Normal Polar Chart Orientation*

Ɵ (the beam rotation angle) is calculated as follows:
[1]Ɵ (radian) = ATAN2 (-1*X, -1*Y) or
Ɵ (radian) = ATAN2 (-1*(-.3), -1* (-.2)) = 0.588
[2]Ɵ (degrees) = DEGREES (.588) = 36.690.
Finally, convert the angle to all positive values: If Ɵ (degrees) < 0, add 360
R (radius) = SQRT($X^2 + Y^2$) = 3.6056

[1] *In Excel: In MS Visual Studio, use* Ɵ *(radian) = Math.ATAN2 (-1*Y, -1*X)*
[2] *In Excel: To manually convert radians to degrees, multiply radians by 57.29577951308232 (180/ Π).*