

Operations Manual

Spindle8 Alignment Software

March 2019



HAMAR LASER INSTRUMENTS, INC.
www.hamarlaser.com

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

WARRANTY

Hamar Laser Instruments, Inc., warrants each instrument and other articles of equipment manufactured by it to be free from defects in materials and workmanship under normal use and service, its obligation under this warranty being limited to making good at its factory any instrument and other article of equipment which shall within one year after shipment of each instrument and other article of equipment to the original purchaser be returned intact to Hamar with transportation prepaid, and which Hamar's examination shall disclose to Hamar's satisfaction to have been thus defective; other than this express warranty, Hamar neither assumes nor authorizes any other persons to assume for it any other liability or obligation in connection with the sale of its products.

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.

The software described in this manual is furnished under a license agreement and may be used or copied only in accordance with the terms of the agreement. It is against the law to copy the software on any medium for any purpose other than the purchaser's personal use.

The information in this manual is subject to change without notice. No part of this manual may be reproduced by any means, electronic or mechanical, without written permission from Hamar Laser Instruments, Inc.

**© Copyright Hamar Laser Instruments, Incorporated, 2019
5 Ye Olde Road, Danbury, Connecticut 06810**

Table of Contents

| | |
|--|----|
| Introducing the L-700 Spindle Alignment System | 1 |
| System Features | 1 |
| Hardware Overview | 2 |
| Model L-700 Spindlemaster™ Laser | 2 |
| Laser Controls | 3 |
| The On/Off Switch | 3 |
| The Shutter Control | 3 |
| Centering and Angular Adjustments | 3 |
| Replacing the Battery | 3 |
| The T-261 Four-Axis Target | 4 |
| The R-358 Computer Interface | 4 |
| Preparing for an Alignment | 5 |
| Hardware Configuration | 5 |
| Hardware Mounting | 5 |
| Stops | 6 |
| Maintenance and Cleaning | 6 |
| Tools and Equipment | 6 |
| Other Considerations | 6 |
| Qualifying and Calibrating Lasers and Targets | 6 |
| Setting up the Spindle Alignment Hardware | 7 |
| Connecting to a Computer Interface | 7 |
| Connecting to the R-358 Computer Interface | 7 |
| Getting Started With the Spindle8 Software | 8 |
| Program Installation | 8 |
| Quick Start | 8 |
| Performing an Alignment with the Spindle8 Software | 11 |
| Using the Spindle8 Checklist | 11 |
| Using the Setup Screen (Checklist Step 1) | 12 |
| Company Information (Alt-C) | 12 |
| Machine Setup (Alt-M) | 12 |
| Units (Alt-U) | 14 |
| Display (Alt-D) | 14 |
| Tolerance (Alt-L) | 14 |
| Record Mode (Alt-R) | 15 |
| Data Source (Alt-S) | 15 |
| Target Setup (Alt-T) | 16 |
| Dual-Spindle Alignment | 18 |
| Laser Qualification – Adjust Laser Angle (Checklist Step 2) | 19 |
| Ways Verification – Straightness and Flatness (Checklist Step 3) | 21 |
| Record Data/Adjust First Angle (Step 4) | 23 |
| Adjust Second Angle and Center (Step 5) | 26 |
| Dual Spindle Alignment (Step 5) | 27 |
| Generating an Alignment Report | 27 |

| | |
|--|----|
| Appendix A – The NORMIN Method (Bore and Spindle)..... | 29 |
| Appendix B – Qualifying the Laser | 31 |
| The NORMIN Procedure | 31 |
| Adjustments..... | 32 |
| Manual/Software-Assisted Qualification | 32 |
| Hardware Requirements..... | 32 |
| Manual Qualifying Procedure | 33 |
| Setup..... | 33 |
| Adjusting the Laser Angle..... | 33 |
| Adjusting the Laser Centering..... | 34 |
| Checking Results..... | 34 |
| Appendix C – Target Calibration..... | 35 |
| Calibration Setup..... | 35 |
| Calibrating a Center-Only Target | 37 |
| Calibrating a Center-and-Slope Target..... | 37 |
| Appendix D –Troubleshooting Guide..... | 39 |

Introducing the L-700 Spindle Alignment System

The L-700 Spindle Alignment System is a complete alignment system for single or dual spindles. A laser and target are mounted between the spindle and the master part. The laser projects a beam. The center and angle of the laser beam in respect to the target determine the misalignment. The target is connected through an interface to a computer running the Spindle8 software, which provides a real-time graphic display of the alignment process. Spindle8 software is offered as a standalone program. The software runs on any Pentium PC-compatible computer running Microsoft Windows.



Figure 1 – Spindle Alignment System

System Features

- **Complete Spindle Alignment System**
The spindle alignment system includes the laser, target, computer interface and software and a storage case.
- **Single or Dual Spindle Capability**
The spindle alignment system aligns single spindles or dual spindle heads.
- **Step-through Checklist**
The Spindle8 software uses an easy-to-follow checklist, with illustrations and step-by-step instructions prompting the user for information to complete each stage of spindle alignment.
- **Dynamic Misalignment Display**
The real-time display moves, showing changes in alignment as they are made.
- **Manual Data Mode**
The Spindle8 software has a manual data mode that allows the program to run without being hooked up to the alignment hardware. This simulation allows the user to become familiar with the software before performing an actual alignment.
- **Comprehensive Reporting Function**
Generate and save reports that include collected data and graphical views of the alignment. Reports can be modified and printed.
- **User-Definable Tolerances**
Alignment tolerances can be as tight or relaxed as the user requires for accuracy or speed. Accuracy assures precision and longer tool life; speed allows less downtime for repairs.

Hardware Overview

This section provides a description of the hardware used in spindle alignment. The laser and target are factory-qualified and calibrated and require no adjustments by the user.

Model L-700 Spindlemaster™ Laser

The Model L-700 Laser is a low-power, Class II visible light laser designed to mount in the spindle of a machine tool to project its axis of rotation during alignment. Vertical and horizontal controls on the front allow the user to fine-adjust the laser's angle and center to the spindle's precise axis of rotation. The visible beam makes coarse alignment much easier, requiring no viewing devices. A simple shutter on the front closes off the beam for safety. The L-700 is designed for applications where the distance between target and laser is approximately 30 ft. (9.1 m). The L-701, which is identical in appearance and function to the L-700, has a slight modification to the beam pointing mechanism which allows finer angular adjustment over long distances, extending the adjustment operating range to 100 ft. (30.5 m).



Figure 2 – L-700 Spindlemaster Laser

Built-in levels on the top and bottom provide easy indexing when inverting for error correction readings. Other features include a shutter to protect the optics and an LED to indicate when the beam is on. Power is provided to the laser by a standard 9V battery for up to 8 hours of operation. A .5 in (12.7 mm) mounting stud simplifies fixturing and can be removed to adapt the unit to custom fixtures or other alignment applications.

These compact, self-contained lasers run for up to 8 hours on a standard, replaceable 9-volt battery, eliminating wires and external power sources. They measure 4 in. long, 3 in. high, and 1.75 in wide, and their durable aluminum case and stainless steel mounting stud are made to withstand the most demanding shop floor environments.

The L-700 and L-701 work with any Hamar Laser target, readout, or interface. They can be used for many types of alignment jobs, including spindle and bore alignment, and measuring and correcting the alignment of a workpiece on the machine.

Applications include:

- Transfer-line spindles
- Rotary dial machines
- Boring bars
- Turning applications (cylindrical, OD/ID grinders, lathes)
- Twin-barrel extruders

Features:

- Simple fixturing for mounting the laser and target.
- Mounts in the spindle to project its axis of rotation, allowing even the largest transfer line machines to be aligned quickly and effortlessly.
- Vertical and horizontal controls on the front for both angle and center for fine-adjustment of laser to spindle axis of rotation.
- Targets provide live measurement data in 4 axes (vertical and horizontal angle and center).
- Visible-light beam aids setup.
- Runs for up to 8 hours on a standard, replaceable 9-volt battery.

Laser Controls

The On/Off Switch

The laser has a small ON/OFF switch, located on the bottom of the laser housing behind the lower bubble level (see Figure 3). When the laser beam is switched on, the red LED on the faceplate lights up to safely indicate that the unit is on.

The Shutter Control

The shutter control closes off the laser beam to protect the user from accidental eye contact with the beam. It also protects the laser's lens from dust or damage. The shutter control is a simple slotted screw head on the lower left side of the faceplate (see Figure 4). Use a straight-edge screwdriver to open or close the shutter.

Centering and Angular Adjustments

The laser also has centering and angular adjustments on the faceplate. The beam is emitted from the large hole in the center. Figure 4 shows the location of the various adjustment screws.

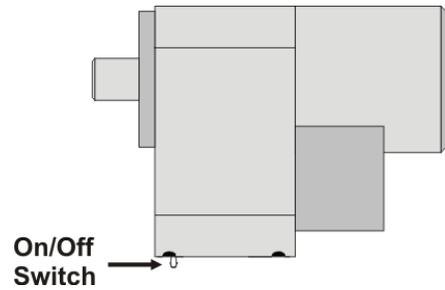


Figure 3 – On/Off Switch

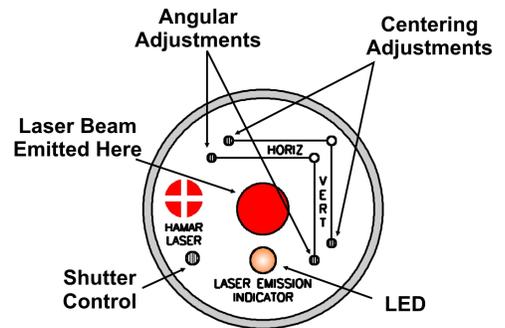


Figure 4 – Shutter Control and Adjustments

Replacing the Battery

The L-700 and L-701 Lasers use a standard, replaceable 9-volt battery for up to 8 hours of continuous use. For best results, use alkaline or rechargeable nickel-cadmium (NiCad) batteries.

To install or replace the battery:

1. Remove the battery cover.

Using the 3/32" hex key included with the laser, loosen the two hex screws on either side of the bubble level. The screws do not need to be removed.

2. Slide the cover out.

Pull the cover straight out of the laser to access the battery.

3. Replace the battery.

Remove the battery (rock it gently from side to side to disconnect it) and replace it with a new 9-volt battery. Make sure the battery is seated in the clips. If the battery won't snap in, check to see if the clips are bent or distorted.

4. Slide the cover on and tighten the screws.

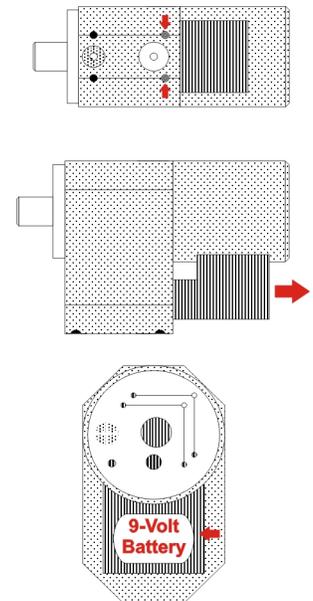


Figure 5 – Replacing the L-700 Laser battery

The T-261 Four-Axis Target

The T-261 Four-Axis Target reads both center and angle (pitch and yaw) simultaneously, allowing a real-time display of misalignment. Readings are accurate to .0001 in/ft. in angle mode and .0001 in. in centering. Two bubble levels on the top and bottom make it easy to position when inverting for NORMIN readings (see Appendix A – *The NORMIN Procedure*, beginning on Page 29).

When the target is purchased as part of a system, it is calibrated at the factory before shipping. If the target is purchased separately, the user must calibrate it before use. An alignment/calibration fixture and a target stand, available from Hamar Laser, are required for calibration. The procedure is outlined in Appendix C–*Target Calibration*, beginning on Page 35.



Figure 6 – T-261 Four-Axis Target

The R-358 Computer Interface

The R-358 computer interface provides high accuracy (.00002 in. or 0.0005 mm resolution) for downloading live target data into a computer and compact size. It attaches to the computer with an RS-232 cable and is powered by a lithium ion battery for long life and usage and automatically turns on when the target starts taking measurements. An AC adapter/charger is provided, and the unit features "charging" and "power" LED indicators.

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 Configuration

Spindle8 is designed to measure and align a spindle to a master part. In most applications, the master part is used as a reference to align the spindle. The software fully compensates for mounting errors of both the laser and target with extremely accurate results.

In an automotive transfer line or a rotary dial machine, a master part is normally the best way to establish a reference for the alignment of spindles at each workstation. The master part is transferred to each station, using the transfer mechanism for the actual part, and the spindles are aligned to the master part. *Either the laser or target may be mounted in the master part.*

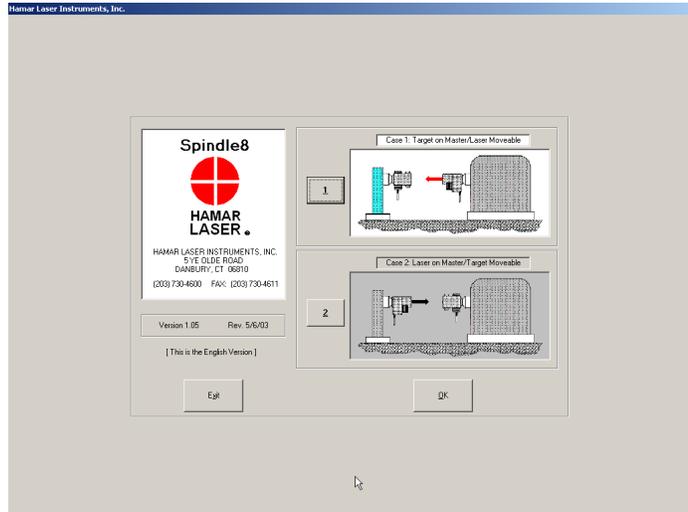


Figure 7 – Selecting Hardware Setup

The first selection made is the Spindle8 software is determined by where the laser and target are mounted. The software defines **Case 1** as the *target* mounted in the master part and the *laser* mounted in the spindle. This is the preferred method for aligning the spindle axis itself. In **Case 2**, the *laser* is mounted in the master part and the *target* is mounted in the spindle. This is the preferred arrangement for making the slides straight and flat and the line of motion parallel to the master part axis. Determine how the equipment will be set up (two opposing spindles, spindle to master part, or two spindles to a master part) and upon which unit the target or laser will be mounted.

Note: It may be necessary to design a master part. If one exists, ensure that it is checked and cleaned.

Hardware Mounting

Mount the laser on the spindle or master part. This may involve creating a fixture to hold the target and/or laser in place. Both the target and laser have a standardized 1/2 in. mounting stud that simplifies fixturing and that can be removed to adapt the unit to custom fixtures or other alignment applications. A .500 in. reamed hole that is square to a face is all that is required to mount the component.

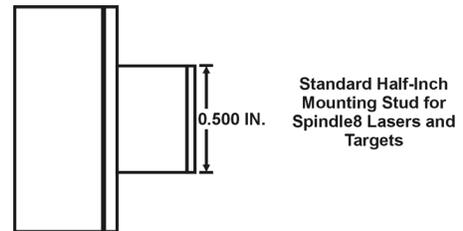


Figure 8 – Mounting Stud

Stops

It may be necessary to design a positive stop to keep the laser and target from colliding.

Maintenance and Cleaning

The spindle to be aligned should be checked thoroughly to ensure that it is clean and working properly.

Tools and Equipment

Determine all the necessary tools and equipment (other than what Hamar Laser supplies) that will be needed for performing an alignment, such as torque wrenches, shims, and equipment manuals.

Other Considerations

- Measure the travel distance of the moveable unit. This information is necessary for the software setup. Use only the distance that the unit realistically travels during use, not the full distance of which it is capable.
- Keep records of all procedures. Log all data file names and keep record copies of all reports and printed data.

Qualifying and Calibrating Lasers and Targets

Lasers and targets must be qualified before use. In the case of the laser, the beam must be parallel and centered to the axis of its mounting stud. In the case of the target, the target cell must be centered and perpendicular to the axis of its mounting stud. All Hamar lasers and targets are shipped factory qualified and ready for use. No further adjustments are needed.

The alignment software and NORMIN procedure are designed to account for and cancel out mounting errors automatically without hardware adjustments. Sometimes, however, it may be desirable to further qualify the laser when it is mounted in a spindle so that the beam reflects the spindle's axis of rotation. This is accomplished using the Read8 program (see Appendix B – *Qualifying the Laser*, beginning on Page 29).

Hamar targets are designed to give accurate readings in spite of small mounting errors with no field adjustment. Attempts by the user to qualify the target are discouraged, as this can lead to damage or inaccurate alignment.

Targets must also be calibrated. When purchased as part of a system, target calibration factors are provided. If the target is purchased separately, the user must calibrate it before use. An alignment/calibration fixture and a target stand, available from Hamar Laser, are required for calibration. The procedure is covered in Appendix C, *Target Calibration*, beginning on Page 35.

Warning!!

Attempts by the user to adjust the internal mechanism of the laser and/or target can cause damage and void the warranty.

Setting up the Spindle Alignment Hardware

Mount the laser and target on the machine, making sure all mounting surfaces are clean and de-burred and that the adapters attach squarely and securely to the laser and target, as well as to the spindle or master part. If positive stops are needed to prevent the laser and target from colliding, they should be placed at this time.

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 software to perform calculations, display live laser beam-to-target position information, and plot results.

- The R-358 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 in.) and high-resolution (.00004 in.) versions.

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/adaptor is plugged in. Make all connections with computer power 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.

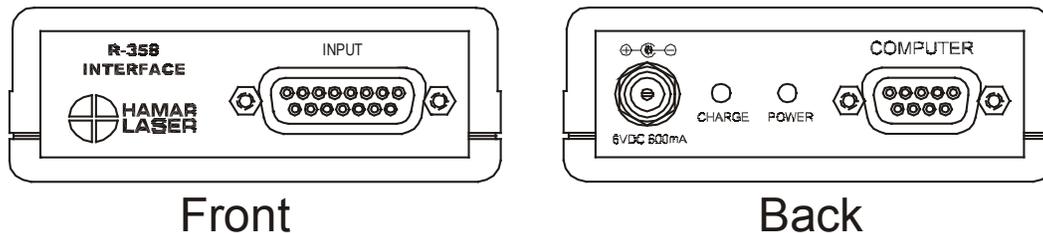


Figure 9 – R-358 Interface Connections

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. Power on the computer.

Getting Started With the Spindle8 Software

Spindle8 is a standalone program that runs on the Microsoft Windows operating system. If an alignment *system* is purchased, the software will be installed on the computer's hard drive.

If the software is purchased separately or as an upgrade, it will be supplied on an installation CD or as an authorized download directly from Hamar Laser Instruments. Install the program on your computer as follows:

Program Installation

1. Insert the program CD in the appropriate drive.
2. Click **Start** and select **R**un.
3. Type *X:\Setup* (with *X* designating the letter of your CD ROM drive) and follow the instructions on the screen.

Quick Start

This section is designed to introduce the actions used to select features and tasks while using the Spindle8 software and to provide a quick start to users already familiar with Hamar Laser's Spindle7 program. 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-T** while working in the Setup Screen will display information for the **T**arget Setup tab.
- The names of buttons in the Spindle8 program are referred to in bold type: for example, **OK**.

To begin using the Spindle8 software, double click the Hamar Laser icon or select the program from the Windows Start Menu. The initialization screen displays. Click **OK** to enter the program.

Select the appropriate case for your hardware setup, (see Figure 7) depending upon whether the target or the laser is mounted on the moveable unit, and click **OK** to display the Spindle8 Alignment Checklist (see Figure 10).

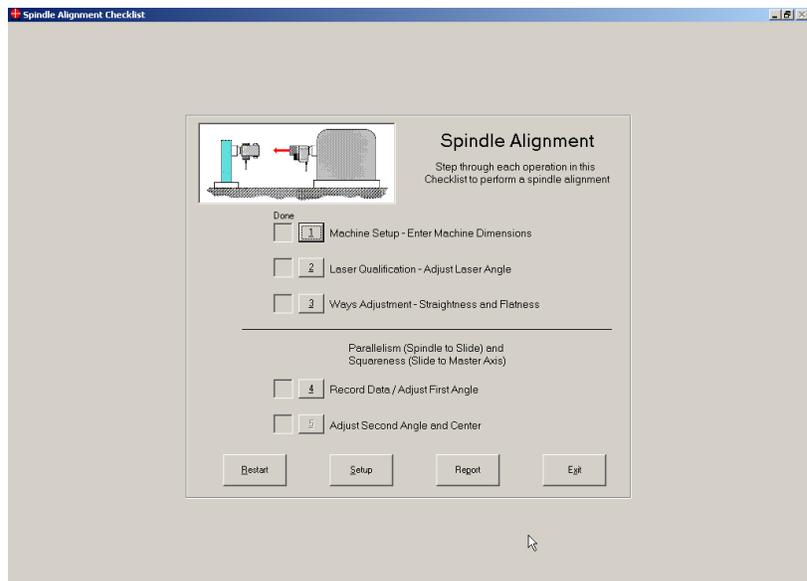


Figure 10 – Spindle Alignment Checklist

Clicking Step 1 (or pressing **1** on the keyboard) displays the Machine Setup categories, which are arranged on tabs (see Figure 11). To activate a category, click on the tab or press and hold down the Alt key while pressing the underlined character, for example, **Alt-T** to display the **Target Setup** tab.

All operating modes and parameters are defined through the Setup Screen before running the Spindle8 program, including the target(s) to be used, units of measure, etc. The selected settings may be saved by clicking **Save Settings** or by pressing **Alt-V** from the Setup Screen. Settings are saved along with report data to sequentially numbered files, beginning with **SPIN001.rpt** (see Figure 12). Each file is date and time-stamped, and comments may be added to each saved setup file. You may change these file names or accept the default name. These files may be viewed and loaded from the Setup Screen by clicking **Load Settings** or pressing **Alt-E** (see Figure 13).

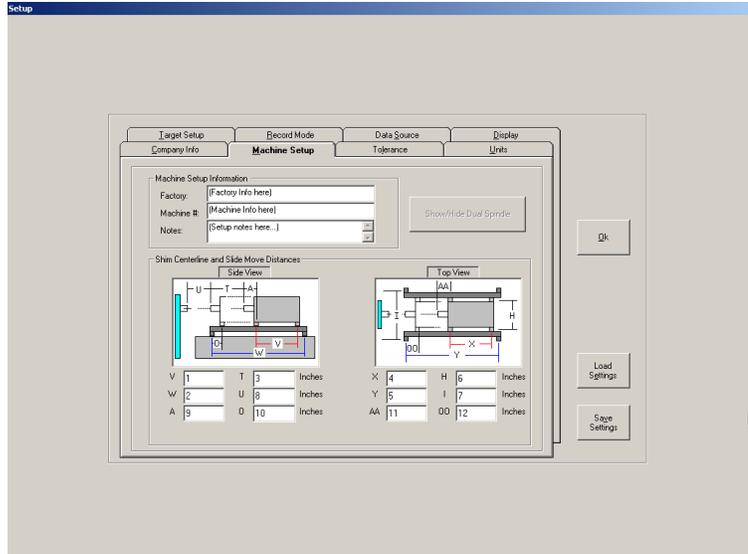


Figure 11 – Setup Categories (Machine Setup Screen shown)

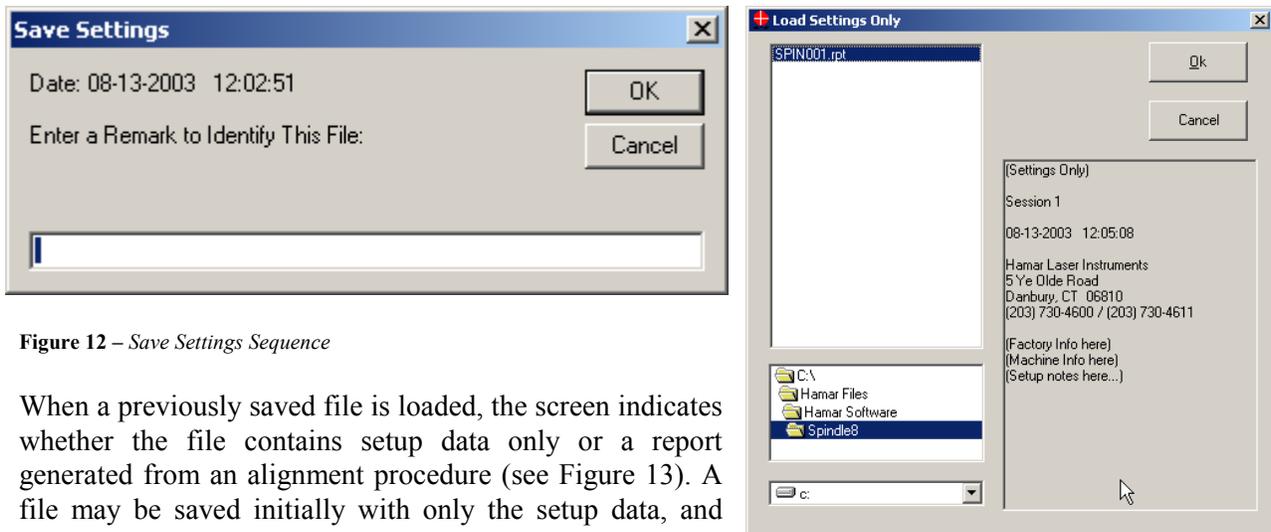


Figure 12 – Save Settings Sequence

When a previously saved file is loaded, the screen indicates whether the file contains setup data only or a report generated from an alignment procedure (see Figure 13). A file may be saved initially with only the setup data, and then saved with the same filename after an alignment report is generated.

Figure 13 – Load Settings

Briefly, the user will perform the following actions from the Setup Screen (for a detailed discussion, see the section of this user's guide titled *Using the Setup Screen* beginning on Page 11).

*Note: The Spindle8 program records all selections made in the Setup Screen each time you exit the program. When the program starts, it uses the setup information recorded during the **previous session**.*

- Select a target.
- Specify machine setup information.
- Provide tolerance information.
- Select the source of data input (an actual target, manual data entry or random data entry for demonstration purposes).
- Specify the number of samples per reading.
- Specify any other relevant operating parameters (such as units of measure to be used and decimal places to be displayed) by clicking the various tabs of the Setup Screen.

Once parameters are entered, they may be saved to a file by clicking **Save** (**Alt-V**). Specify a name for the file or accept the default filename provided, and then click **OK** to begin following the procedures in the Spindle8 Checklist (see Page 9 for detailed information about loading and saving a setup configuration).

Notes:

1. *The numeric displays for all screens show dashes (- -) on channels for which a target is not connected and/or not communicating.*
2. *The numeric displays show OFF TGT for any channel for which a target is selected, connected, and communicating, but which the laser beam is not currently hitting.*

Depending on the particular checklist procedure, buttons at the bottom of each screen allow the user to do the following:

- **Restart (Alt-R)** clears all recorded information taken during a checklist procedure so that it may be retaken.
- **Record (Alt-D)** records a reading. Readings may also be recorded by pressing the spacebar.
- **Checklist (Alt-C)** returns to the checklist.
- **Setup (Alt-S)** returns to the setup screen.
- **Next (Alt-N)** displays the next screen in the alignment procedure.

Performing an Alignment with the Spindle8 Software

This section provides detailed instructions for using the individual features of the Spindle8 software, including program setup and personalization, selecting target information, viewing and recording target data, and correcting misalignment.

Using the Spindle8 Checklist

The Spindle8 Checklist (see Figure 10) provides five procedures to complete a spindle alignment. Each procedure includes step-by-step instructions. When a procedure is complete, an **X** displays in the box marked “Done” next to the procedure number. A procedure may be selected by clicking on the numbered button or by pressing the Alt key plus the step number, for example, **Alt-2** (or by typing the number **2**).

The four buttons at the bottom of the Coupling4 Checklist screen are used as follows:

Restart

Click **Restart** or press **Alt-R** to clear information entered on all screens and restart the Spindle8 alignment procedure.

Setup

Click **Setup** or press **Alt-S** to modify the Spindle8 Alignment setup.

Report

Click **Report** or press **Alt-P** to create a report using the collected data. You can include an image of the Step 1 setup procedure and the final coupling alignment display. The report may be modified, saved and printed.

Exit

Click **Exit** or press **Alt-X** to exit the Spindle8 Checklist and return to the case selection screen.

Using the Setup Screen (Checklist Step 1)

The Setup Screen displays tabs corresponding to each feature of the Spindle8 program. All program settings are defined from the Setup Screen, either by selecting the appropriate tab or by using the keyboard shortcuts. For example, to select Target Setup, click on the Target Setup tab from the Setup Screen or press **Alt-T** while the Setup Screen is active. To exit the Setup Screen, click on **OK** or use the keyboard shortcut, **Alt-O**.

***Note:** The Spindle8 program records all selections made in the Setup Screen each time you exit the program. When the program starts, it uses the setup information recorded during the **previous session**. For example, company name and address information entered on the Company Info tab will be automatically displayed the next time the program starts.*

Company Information (Alt-C)

Click on the Company Info tab of the Setup Screen to personalize your version of the Spindle8 program. The program uses this information as part of a report header when printing reports. To move among the fields, either press the Tab key or position the mouse cursor in each field and click.

Machine Setup (Alt-M)

Click on the Machine Setup tab of the Setup Screen to enter factory and machine information, as well as any additional notes on a particular machine setup. This information is also incorporated into the header of printed reports. To move among the fields, either press the Tab key or click in each field. When the text of a note fills the Notes box, click on the up arrow (↑) or down arrow (↓) in the scrollbar to the right of the box to see the entire text of the note.

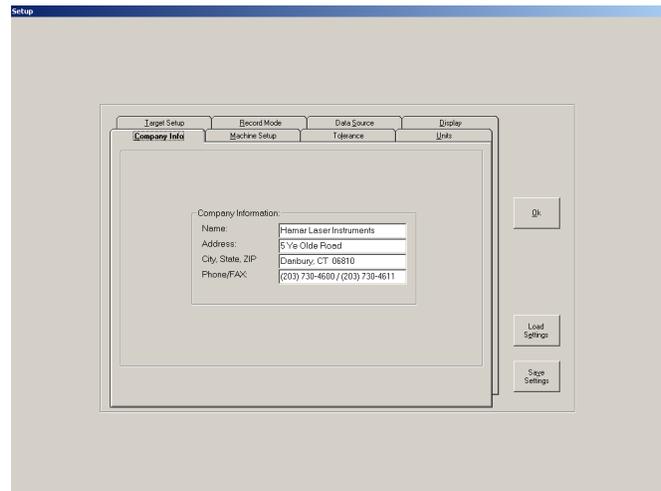
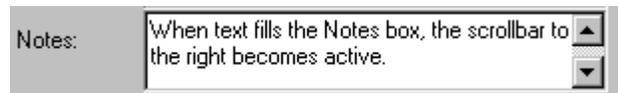


Figure 14 – Company Info Setup Screen



Shim Centerline and Slide Move Distances

The bottom half of the Machine Setup Screen is used to enter required measurements for the spindle alignment setup.

- The machine views (top view and side view) can be *reversed* by placing the mouse cursor inside either of the graphics. When the cursor changes to a double arrow, click to reverse the view to correspond with your setup.
- To obtain a description of each lettered value, click either on the letter itself within the graphic or in the box next to the corresponding letter below. The box turns yellow and a large blue arrow identifies the selected letter. A detailed description of the value displays at the bottom of the screen (see Figure 15).

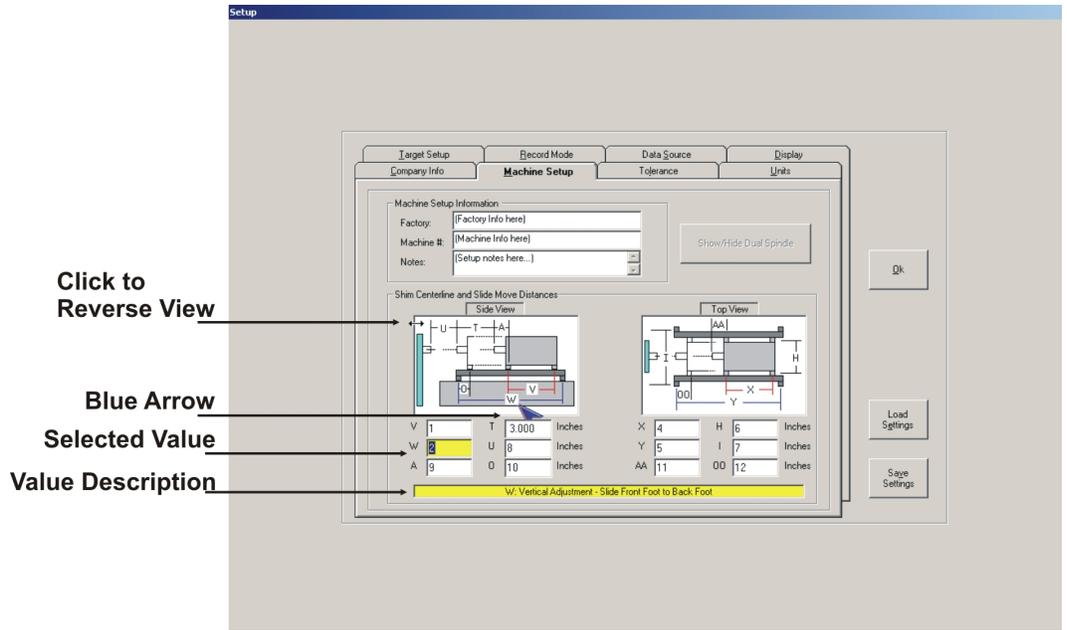


Figure 15 – Machine Setup Screen

Show/Hide Dual Spindle

If a Dual Spindle alignment has been specified in the Target Setup screen, additional dimensions must be specified. To activate the Dual Spindle Dimensions area of the Machine Setup screen, click **Show/Hide Dual Spindle**. To obtain a description of each lettered value, click either on the letter itself within the graphic or in the box next to the corresponding letter below. The box turns yellow and a large blue arrow identifies the selected letter. A detailed description of the value displays at the bottom of the screen. For additional information about dual spindle alignment, see *Dual Spindle Alignment* on Page 18.

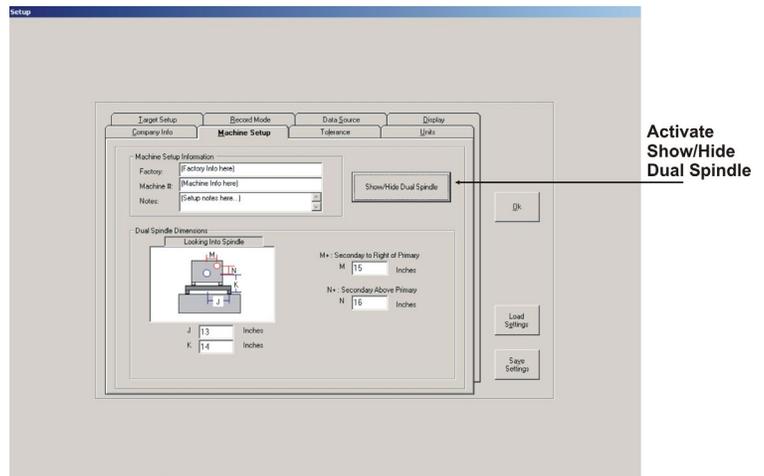


Figure 16 – Show/Hide Dual Spindle

Units (Alt-U)

Click on the Units tab of the Setup Screen to specify measurements in inches or millimeters. Units of measure for the slope may also be specified. The choice will be reflected throughout the Spindle8 program.

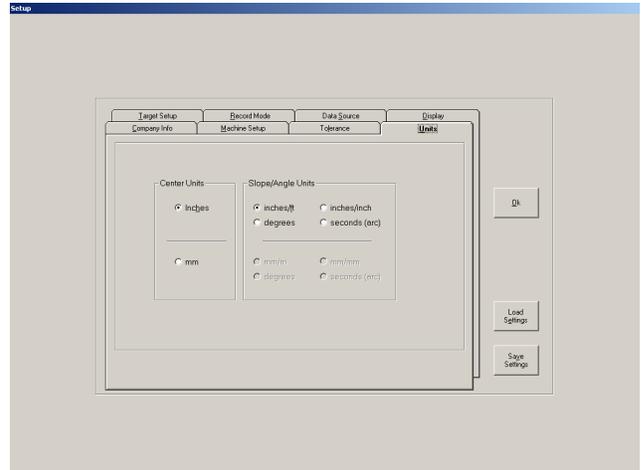


Figure 17 – Units Setup Screen

Display (Alt-D)

Click on the Display tab of the Setup Screen to set the number of decimal places to display target data for center and slope readings (on the alignment screens, *Slope* readings are displayed in yellow italics). For example, when Units is set to *inches* and 3 decimal places are selected, target data displays in thousandths. When Units is set to *millimeters* and 3 decimal places are selected, target data displays in thousandths of a millimeter.

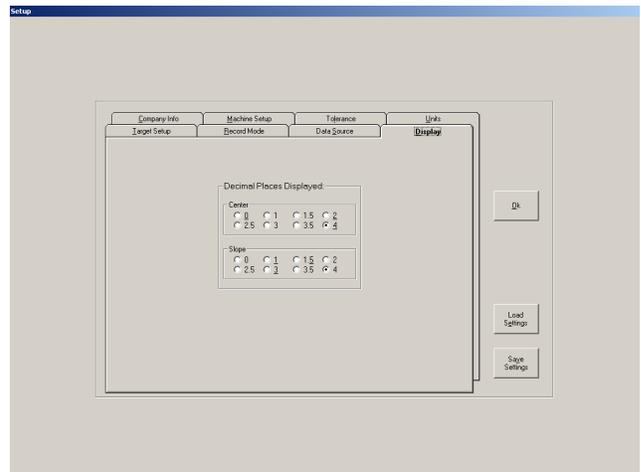


Figure 18 – Display Setup Screen

Tolerance (Alt-L)

When the Tolerance Bands feature is ON and a tolerance value is assigned, the Spindle8 plot windows will display tolerance bands in Step 4 (Live Display) and Step 5. These bands are green when the target reading is within the tolerance value and red when the target reading is outside the range. Tolerance bands also display when performing shims/moves.

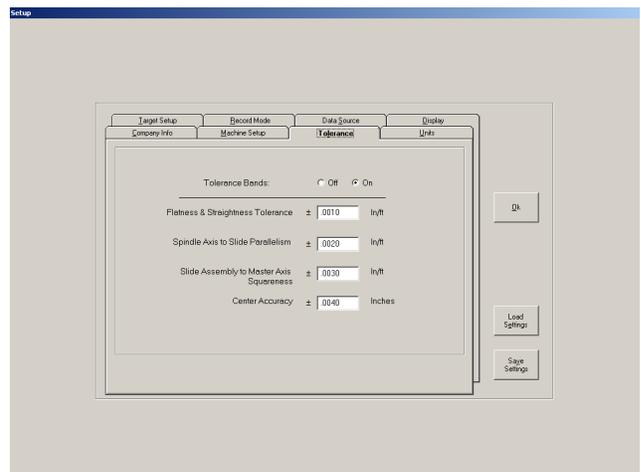


Figure 19 – Tolerance Setup Screen

Record Mode (Alt-R)

Click on the Record Mode tab of the Setup Screen to specify the number of samples to be taken for each reading. To change the number of samples, either highlight the existing number and replace it, or click the up arrow (↑) to increase the number of samples or the down arrow (↓) to decrease the number of samples. You can also specify if you wish audio feedback as each sample is recorded.

Data Source (Alt-S)

Click on the Data Source tab of the Setup Screen to specify the communication port of your computer. You may also enter manual data to override the interface between the target and computer or when using a different readout.

Computer Serial Port – Select the computer serial port (COM 1 or COM 2) to which the interface is connected.

Manual Data – Enter data to create a demonstration or to perform an alignment with data obtained from a dedicated readout that doesn't use an interface. Manual data can also be used when learning the program or performing training exercises. Click on the UP and DOWN arrows to increase or decrease the values. Use the **Step Size** option to select the increment by which the manual data numbers increase or decrease.

Random Data – This feature can be used to randomly generate data for teaching or demonstration purposes. The data range allows the user to select the maximum range of values that will be generated randomly. For example, in Figure 21 the random data generated will fluctuate by ± 0.0050 in.

Note: Actual target data being received by the readout are ignored when Manual Data and Random Data modes are selected.

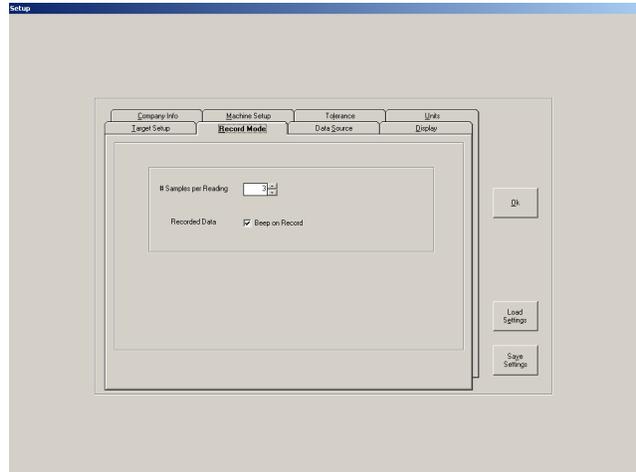


Figure 20 – Record Mode Setup Screen

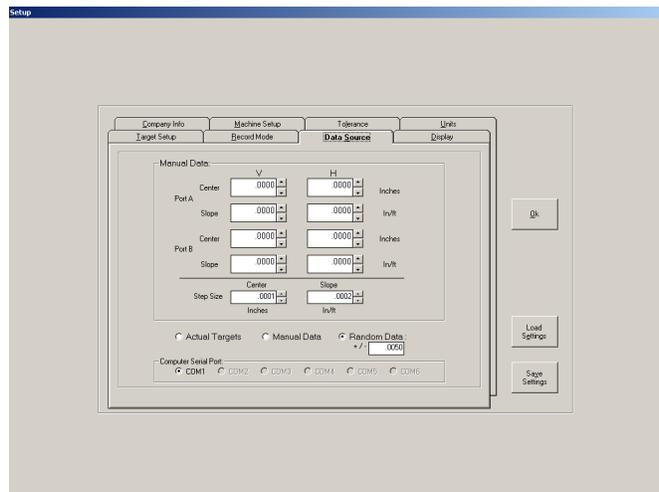


Figure 21 – Data Source Setup Screen

Target Setup (Alt-T)

Click on the Target Setup tab of the Setup Screen to:

Select Single or Dual Spindle Mode

Click Single Spindle or Dual Spindles, depending on your setup. For further information, see *Dual Spindle Alignment* on Page 18.

Interface

Select the interface you are using to connect to your computer.

Select Primary and Secondary Target

Select the primary target you will be using for spindle alignment and a secondary target if operating in Dual Spindle mode. To select a target, click on the down-arrow to see a list of available targets (see Figure 22).

The only valid targets for Spindle8 alignment are the T-261 and T-266. If a complete spindle alignment system is purchased, all the information for the target, including the calibration factors, will be recorded in the Spindle8 software. If no target information displays, select **New Target**.

Select the **Normal Target and Laser Orientation** position according to your setup. The default is “6,” with the target cable and laser switch both facing downward (see Figure 22).

To change information for a target, click on the Edit/Details button to display the Edit Target screen (see Figure 23). From this screen, selected targets can be recalibrated or deleted from the list and saved information can be modified or printed (see Figure 23).

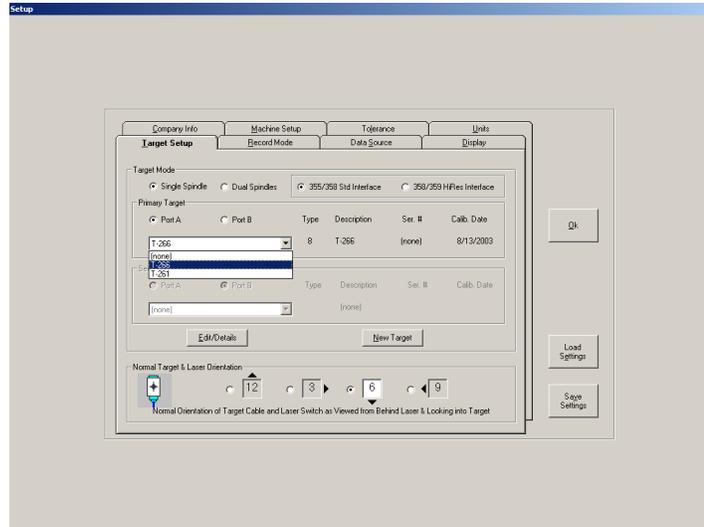


Figure 22 – Target Setup Screen

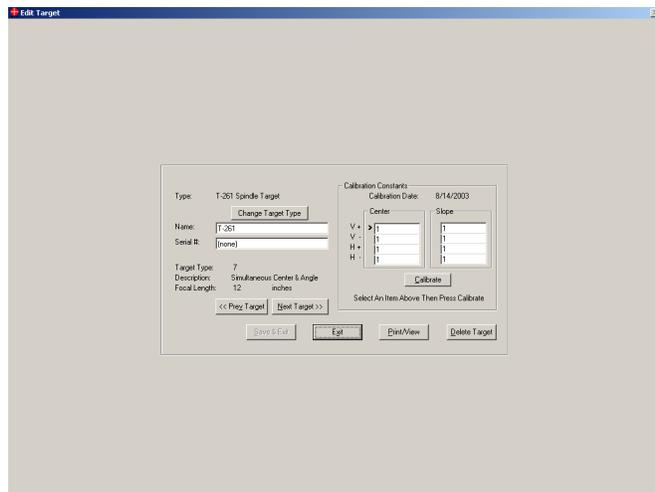


Figure 23 – Edit Target Screen

Selecting a New Target

If no targets have been selected previously or if you wish to add a new target, do the following from the Target Setup screen:

1. Click **New Target button (Alt-N)** on the **Target Setup** screen to display the **New Target** screen (see Figure 24).

2. **Select the type of target you are going to use from the list.**

Click on the down arrow (↓) in the Type list box to select a new target. Enter a name for the target in the Name field, (or keep the default model number as a name) and the target serial number (optional) by clicking in the field and typing the information. The Tab key may also be used to navigate within the New Target screen.

3. **Load Target Calibration Information from disk.**

Your target comes with calibration information on diskette and also in hard copy format. You may either manually enter the calibration information or press **Load Tgt File (Alt-L)** to load the information from the supplied diskette.

4. **Save the information.**

When the target is selected and calibrated, click **Print** or press **Alt-P** to print this information. Click **Save and Exit (Alt-S)** on the New Target screen to return to the **Targets** tab of the checklist.

***Note:** Recalibrating a target requires the A-807 Mounting Fixture and the T-230 Target Stand. If a target must be recalibrated, see Appendix C, Target Calibration, beginning on Page 35.*

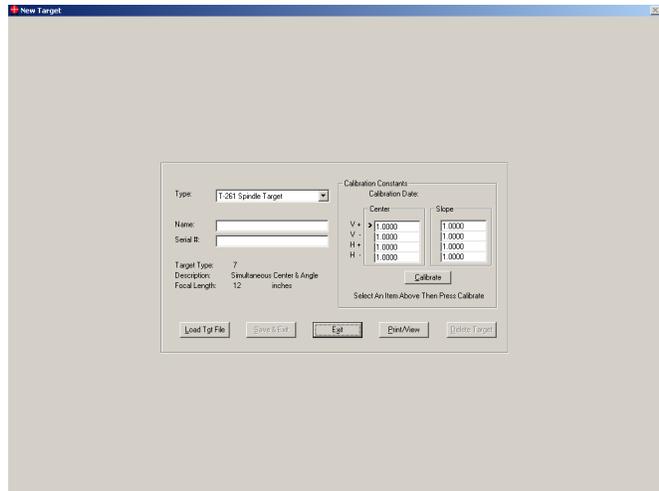


Figure 24 – New Target Screen

Dual-Spindle Alignment

When **Dual Spindle** is selected in the Target Setup, both a primary and a secondary target must be selected. When performing a dual spindle alignment, you have the option of recording data for each target separately or for both targets at the same time.

Figure 25 shows Step 2 (Laser Qualification) of the Spindle8 Checklist with the option box that displays if you are recording data from two targets. Although Step 2 was used as an example, the following applies throughout the program when performing a dual spindle alignment.

- If **Record Single Tgt** is selected, record the data, make the necessary adjustments to the first laser, and then move the cursor into the PRIMARY box at the top left of the screen. The cursor turns to a hand. Click in the box to change the designation to SECONDARY, record the data for the second target, and adjust the second laser.
- If **Record Both Tgts** is selected, record the data, make adjustments to the first laser, and then move the cursor into the PRIMARY box at the top left of the screen. The cursor turns to a hand. Click in the box to display the data recorded for the SECONDARY target and make the adjustments to the second laser.

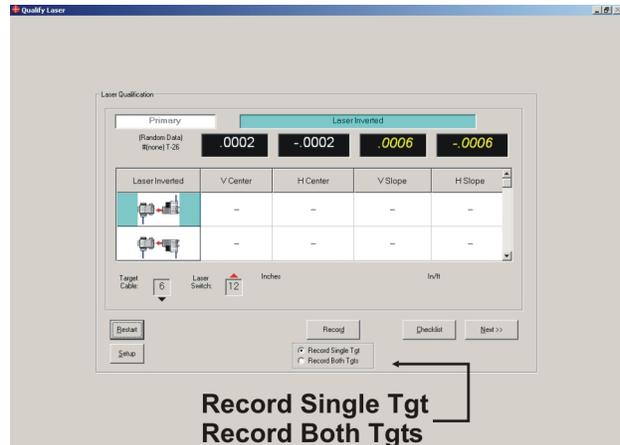


Figure 25

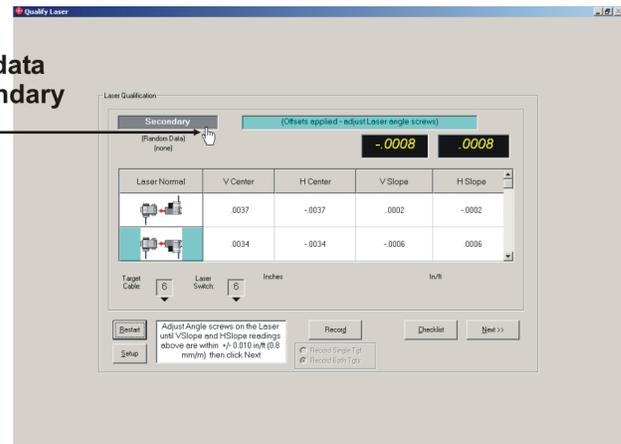


Figure 26

Laser Qualification – Adjust Laser Angle (Checklist Step 2)

Target and laser mounting errors must be compensated for in order to achieve accurate results. The Spindle8 program uses the NORMIN method, developed by Hamar Laser as a quick and precise way to cancel out these errors. The word “NORMIN” is a contraction of “NORMAl-INverted,” which briefly describes the method. The NORMIN readings determine the mounting and other errors in a spindle-mounted target and laser setup.

Each unit, target or laser, is set in the NORMAl position, the other rotated 180 degrees to the INverted position, and a set of INverted readings is taken. Then the laser and target are both set in the NORMAl position and the readings recorded. The readings are then averaged to cancel out both centering and angular mounting errors and provide a very accurate result. The NORMIN procedure is described in Appendix A beginning on Page 29 of this user’s guide.

Note:

In the screens illustrating the Spindle8 Checklist steps in this manual, “6” was selected in the Normal Target and Laser Orientation section of the Target Setup screen. The target cable and laser switch are both facing downward (at 6 o’clock). This is the default selection. Checklist steps 2, 3 and 4 include graphics indicating the orientation of the target and laser according to the selection made in Target Setup. These graphics change as necessary to illustrate the required orientation of your target and laser for each reading.

1. Click Step 2 on the Spindle8 Checklist to bring up the Laser Qualification screen.

Note that the graphic at the bottom left of the screen indicates the *new* orientations for laser and target (Figure 28).

2. Rotate the laser 180° and click Record (Alt-D) or press the spacebar to take the first reading.

Note that once the first reading is taken, the graphic at the bottom left of the screen changes to indicate the *new* orientations for laser and target (see Figure 29).

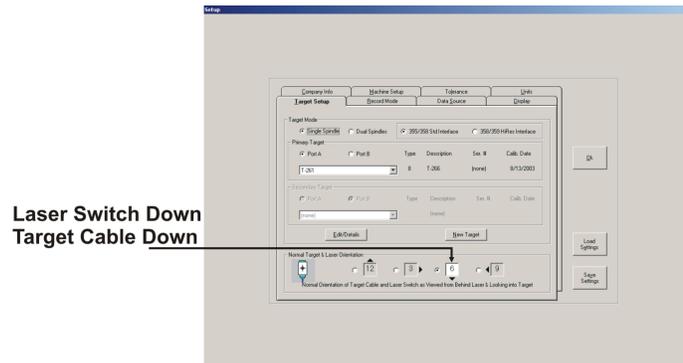


Figure 27 – Normal Target and Laser Orientation

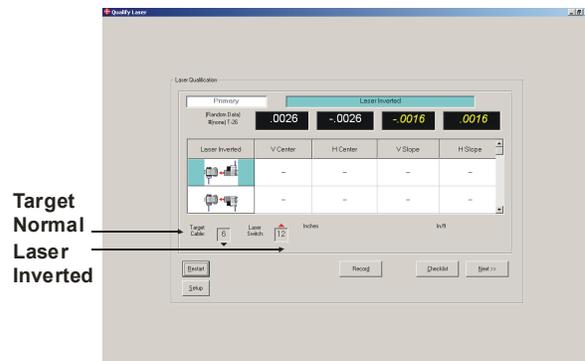


Figure 28

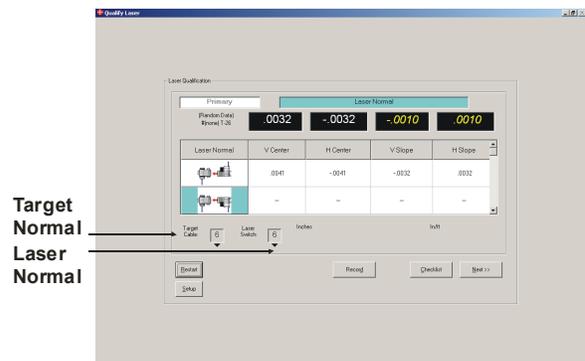


Figure 29

3. Rotate the laser 180° and click **Record** (Alt-D) or press the spacebar to take the second reading.

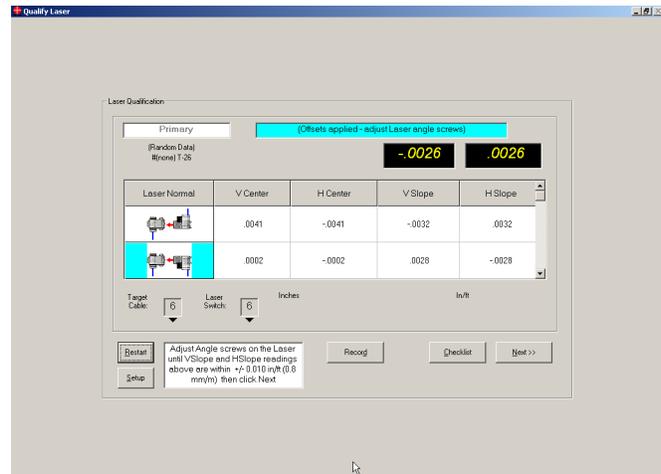


Figure 30

4. Adjust the Angular Adjustment screws on the laser (see Figure 31) until the VSlope and HSlope readings are within ± 0.010 in/ft (or 0.8 mm/m if using metric units) and click **Next** (Alt-N).

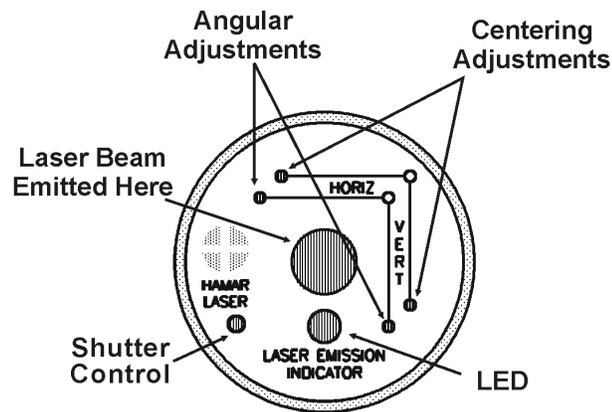


Figure 31

Ways Verification – Straightness and Flatness (Checklist Step 3)

Step 3 provides a coarse check of the straightness and flatness of the wingbase ways to verify that they are in tolerance. If, after performing Step 3, you have values that are out of tolerance, check for possible causes such as loose gibs, abnormal wear, etc. A detailed analysis of this problem requires a scanning laser and Hamar software such as Bore6 or the QuickPlot feature of Read8.

1. Place the moveable unit in the retracted position and take a reading.

Move the spindle head all the way back to the retracted position (away from the master part) and click **Record** (Alt-D) or press the spacebar to take the retracted reading (see Figure 32).

2. Move the unit to the advanced position and take a reading.

Move the spindle head all the way forward (toward the master part) and click **Record** (Alt-D) or press the spacebar to take the advanced reading (see Figure 33).

3. Adjust the ways if necessary.

The graphic on the right side of the screen displays the flatness/straightness status. If the ways are straight and flat within the pre-selected tolerances, the graphic shows straight lines between the laser and target and the **In tol** (within tolerance) boxes turn green and display a checkmark (see Figure 35). If the results are out of tolerance, the graphic shows curved lines between the units as follows:

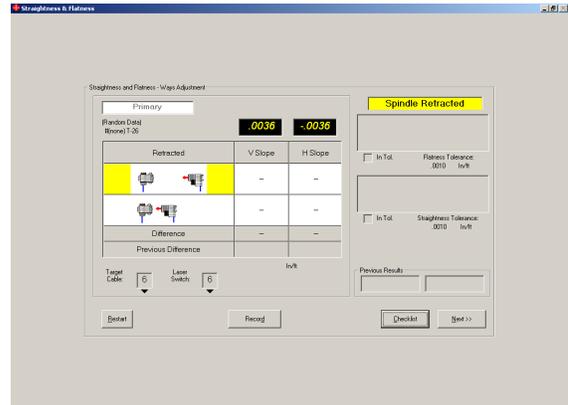


Figure 32 – Ways Adjustment (Retracted)

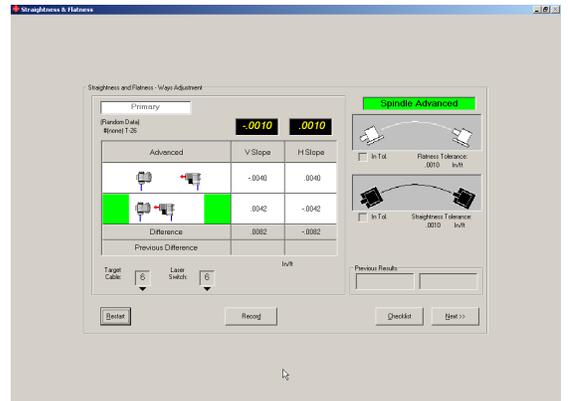


Figure 33 – Ways Adjustment (Advanced)

| Difference | As Spindle Advances: | |
|-------------------------------|-----------------------------|--|
| Horizontal Negative | Rear of spindle moves left | |
| Horizontal Positive | Rear of spindle moves right | |
| Vertical Negative | Rear of spindle drops | |
| Vertical Positive | Rear of spindle rises | |
| Within Flatness Tolerance | | |
| Within Straightness Tolerance | | |

Note that machine views (top view and side view) can be *reversed* by placing the mouse cursor inside either of the graphics. When the cursor changes to a double arrow, click to reverse the view to correspond with your setup (see Figure 34).

4. Click **R**estart (Alt-R) and repeat the procedure.

Retake readings in both the retracted and advanced positions and readjust the machine again if necessary. *Always take a new set of readings for both positions after making any adjustments.* The small graphics at the bottom of the screen (**P**revious Results) display the results from the previous set of data taken (see Figure 35). When the ways are aligned within the specified tolerances, click **N**ext (Alt-N).

Cursor changes to a double arrow

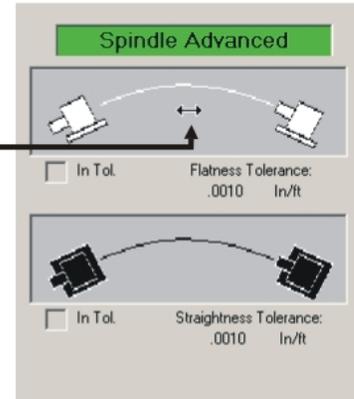


Figure 34

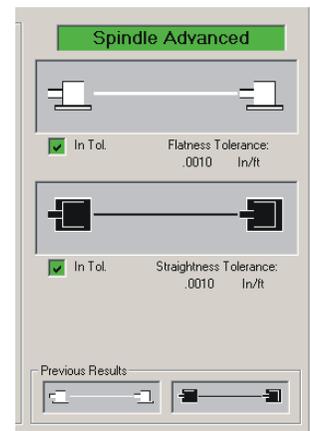


Figure 35 – Straightness and Flatness within tolerances

Record Data/Adjust First Angle (Step 4)

This procedure determines if the wingbase ways are parallel (spindle to slide) and square (slide to master part axis) and allows the user to align them within the specified tolerance. The NORMIN method is used, as shown in Figure 36, and readings are taken with the spindle both retracted and advanced. While performing this step, the screen will always indicate the position for the laser and target.

Note that machine views (top view and side view) can be *reversed* by placing the mouse cursor inside either of the graphics. When the cursor changes to a double arrow, click to reverse the view to correspond with your setup (see Figure 36).

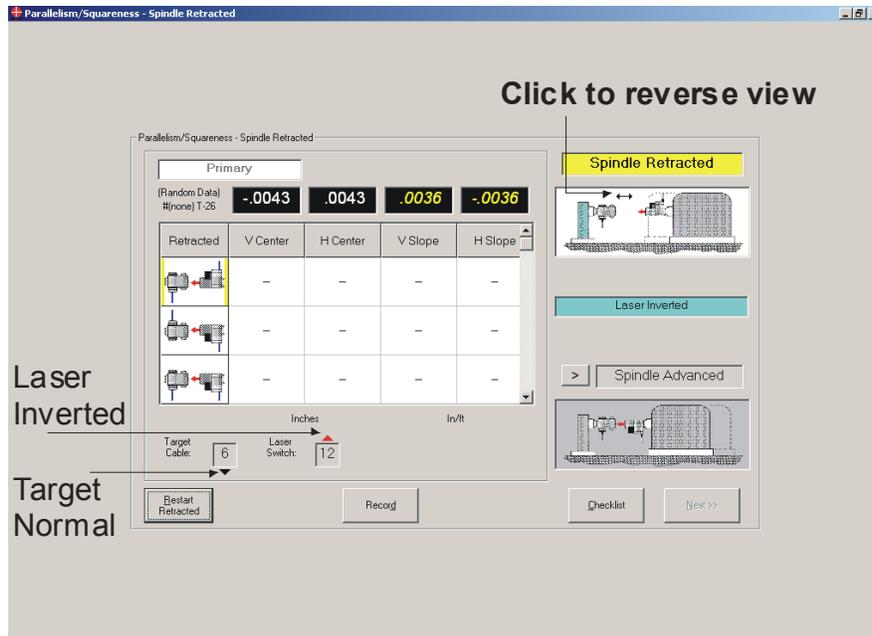


Figure 36 – Checklist Step 4 (Parallelism/Squareness of Ways)

Take retracted readings

- 1. Place the moveable unit in the retracted position and rotate the laser to the inverted position.**
Move the spindle head all the way back to the retracted position (pulled back from the master part). Note that the target is in the NORMal position and the laser is INverted when performing this step (see Figure 36). Click **Record** (Alt-D) or press the spacebar to take the first reading in the retracted position.
- 2. Rotate the laser and target 180° and take a reading.**
With the target in the INverted position and the laser in the NORMal position, click **Record** (Alt-D) or press the spacebar to take the second reading in the retracted position.
- 3. Rotate the target to NORMal position and take a reading.**
With both the laser and target in NORMal positions, click **Record** (Alt-D) or press the spacebar to take the third reading in the retracted position.
- 4. Click Next (Alt-N) or the arrow to the left of Spindle Advanced or press the letter N on the keyboard.**

Take Advanced Readings

1. **Place the moveable unit in the advanced position and invert the laser.**
Move the spindle head all the way forward (toward the master part). Note that the target is in the NORMAL position and the laser is INverted when performing this step. Click **Record (Alt-D)** or press the spacebar to take the first reading in the advanced position.
2. **Rotate the laser and target 180° and take a reading.**
With the target in the INverted position and the laser in the NORMAL position, click **Record (Alt-D)** or press the spacebar to take the second reading in the advanced position.
3. **Rotate the target to NORMAL position and take a reading.**
With both the laser and target in NORMAL position, click **Record (Alt-D)** or press the spacebar to take the third reading in the advanced position.
4. Click **Next (Alt-N)** or press the letter N on the keyboard.

Adjusting the First Angle

The third screen of Step 4 is a static screen showing the collected data in the previous two screens. Once selections are made on this screen, click **Show Live Display (Alt-S)** to make actual adjustments with the assistance of the live display.

Determine the first angle adjustment to be made. If **I** is selected, you are adjusting the parallelism of the spindle to the slide. If **II** is selected, you are adjusting the squareness of the slide to the master axis. For this example, **I** is selected. Whichever selection you make first will be a correction for angle only (correction for center and the other angle will be made in Step 5). Step-by-step instructions are provided at the bottom of the screen.

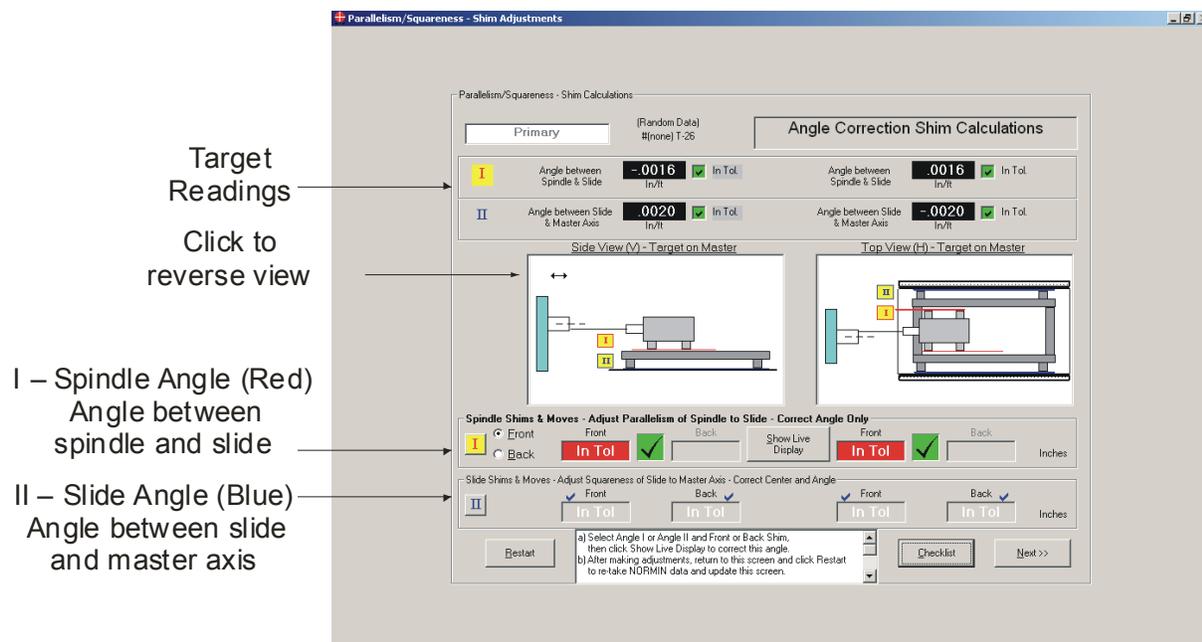


Figure 37 – First Angle Correction Screen (Static)

1. Determine which angle to correct first.

Select **I** or **II** (see Figure 37) and Front or Back (shim and move) depending on your configuration.

2. Click Show Live Display (Alt-S) to activate the live display (see Figure 38).

Note the features available on the live display:

- To *display* the present tolerance value, hold the cursor on the tolerance box. To *change* the tolerance value, click on the tolerance box.
- To reverse the machine view, (top view and side view) place the mouse cursor inside either of the graphics. When the cursor changes to a double arrow, click to reverse the view to correspond with your setup.
- To increase or decrease the scale of the viewing area, hold the cursor over the + (plus sign) or the - (minus sign) in the machine view until it becomes a magnifier. Click to zoom in or out.
- The shim and move values are displayed at the bottom of the screen, along with arrows indicating the direction for shimming or moving. An up arrow (↑) in the shim area indicates that the shim value must be *added* and a down arrow (↓) indicates that the shim value must be *removed*. An up arrow (↑) in the move area indicates that the unit must be *pushed away* from you by the move value, and a down arrow (↓) indicates that the unit must be *pulled toward* you by the move value.

3. Make adjustments until the tolerance boxes turn green and display “In Tolerance.” The arrows become a checkmark. Click <<Prev (Alt-P) to return to the previous screen.

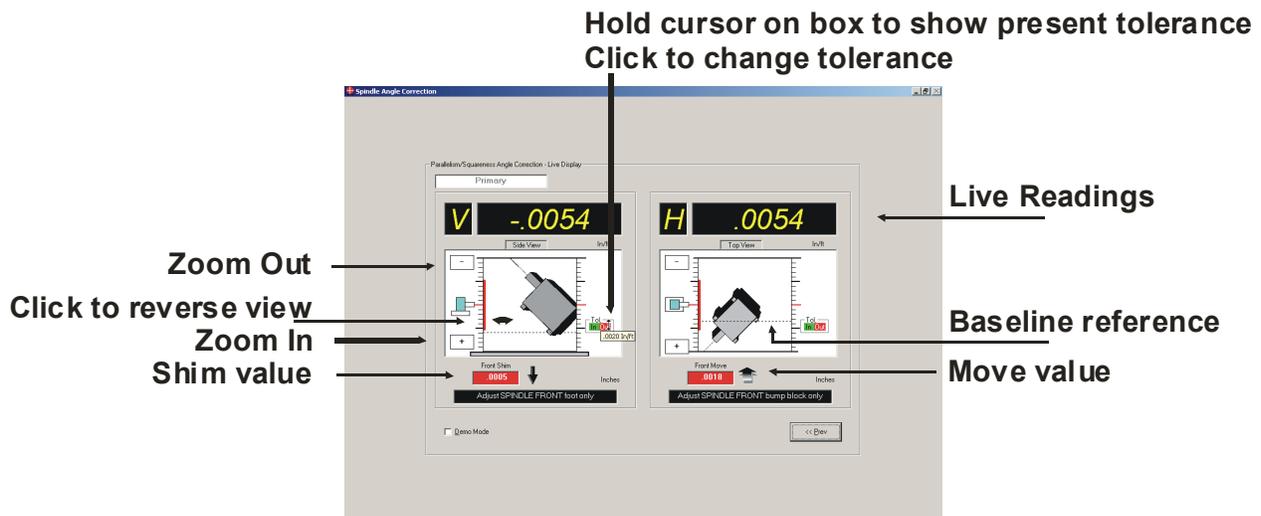
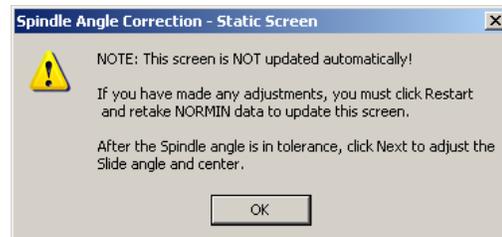


Figure 38 – First Angle Correction Screen (Live)

If you have made adjustments while correcting the first angle, click **R**estart (Alt-R) and retake the NORMIN data to update the static screen. Follow the steps for taking retracted readings on Page 23 and advanced readings on Page 24. When you have verified that the first angle is in tolerance, click **N**ext (Alt-N) to correct the second angle and center (Step 5).



Adjust Second Angle and Center (Step 5)

The screen for Step 5 (Figure 39) provides a live display for adjusting center and slope. Because this screen is used to adjust center *and* angle, there are several additional features, as follows:

- To *display* the present tolerance value, hold the cursor on the tolerance box. To *change* the tolerance value, click on the tolerance box. Tolerance *bands* are red when out of tolerance and green when in tolerance.
- To reverse the machine view, (top view and side view) place the mouse cursor inside either of the graphics. When the cursor changes to a double arrow, click to reverse the view to correspond with your setup.
- To increase or decrease the scale of the viewing area, hold the cursor over the + (plus sign) or the – (minus sign) in the machine view until it becomes a magnifier. Click to zoom in or out.
- The shim and move values are displayed at the bottom of the screen, along with arrows indicating the direction for shimming or moving. An up arrow (↑) in the shim area indicates that the shim value must be *added* and a down arrow (↓) indicates that the shim value must be *removed*. An up arrow (↑) in the move area indicates that the unit must be *pushed away* from you by the move value, and a down arrow (↓) indicates that the unit must be *pulled toward* you by the move value.
- For the primary target, a solid black line represents the slope value and a dashed red line represents the spindle axis center value. If you are performing a dual spindle alignment, see *Dual Spindle Alignment (Step 5)* on Page 27.

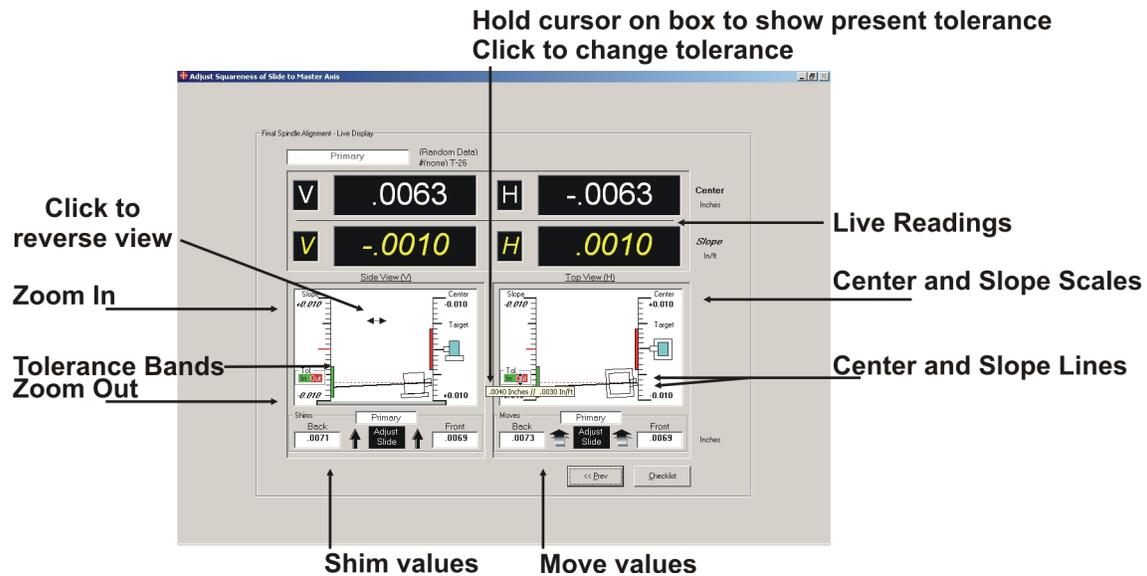


Figure 39 – Second Angle and Center Correction Screen

Make adjustments until the tolerance boxes turn green and display “In Tolerance.” The arrows become a checkmark. Click <<Prev (Alt-P) to return to the previous screen. If you have made adjustments, it is advisable to repeat the Step 4/Step 5 procedures to ensure that all adjustments are valid and within tolerance. When finished, click **C**hecklist (Alt-C) from the Step 5 screen to generate an alignment report.

Dual Spindle Alignment (Step 5)

If you are performing a dual spindle alignment, move the cursor to the Primary box in the upper left-hand corner until the cursor changes to a hand. Click to change to view secondary target information. On this screen, the *dashed black line* represents the center value and the *blue line* represents the slope. Click in the Secondary box to see the *average* of both target readings.

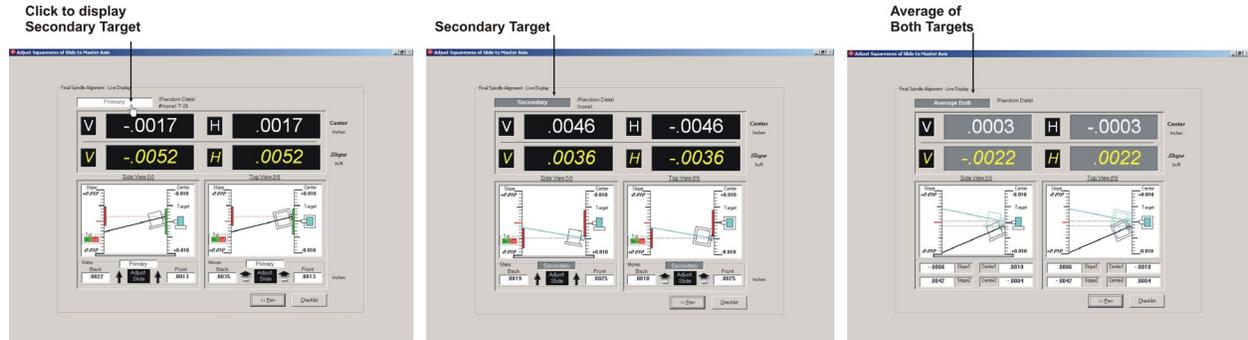


Figure 40 – Dual Spindle Alignment (Step 5)

Generating an Alignment Report

Click **Report (Alt-P)** from the Spindle8 Checklist to generate an alignment report. The report below shows the complete results of a spindle alignment. All the graphic screens are included, along with the setup information and numeric data collected. You can view or print all of the data by clicking **Select All (Alt-A)** or click on an individual item to add or remove it from the report. See the chart on Page 28 for descriptions of the individual features of the alignment report screen.

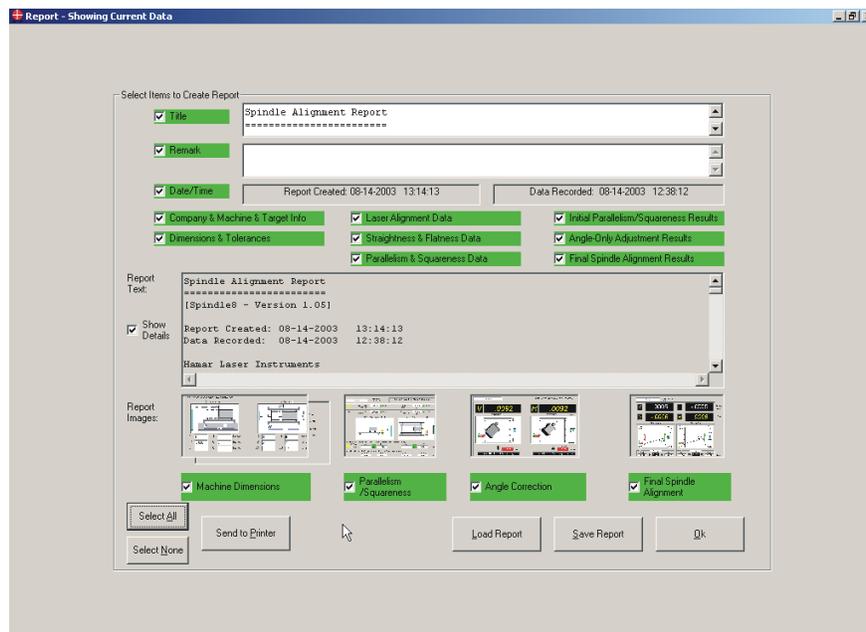


Figure 41 – Spindle Alignment Report

| | |
|---|---|
| Title | Accept the default (program name and version) or change the information to suit your needs. When text fills the box, the scrollbar to the right becomes active. |
| Remark | Add remarks to the report to clarify or comment. When text fills the box, the scrollbar to the right becomes active. |
| Date/Time | Provides the date and time the data was recorded and the report generated. |
| Report Text | Check or clear the items above the Report Text box that you wish to include or exclude from the text of the report. |
| Report Images | Check or clear the images that you wish to include or exclude in the report. To magnify an image for easier viewing, move the cursor over the image until it turns into a magnifier, and then click on the image. To return to the report screen, move the cursor over the enlarged image until it becomes a black arrow and click. |
| Select <u>A</u>ll (Alt-A) Select <u>N</u>one (Alt-N) | Select all the information for inclusion in the report or none of the information. You may then go through the report and selectively check or uncheck individual items. |
| Send to <u>P</u>rinter (Alt-P) | Prints the report. |
| Primary Target Secondary Target Both Targets | When performing a Dual Spindle Alignment, you can select the data recorded for the primary target, the secondary target, or for both targets. |
| <u>L</u>oad Report (Alt-L) | Loads a previously saved report. |
| <u>S</u>ave Report (Alt-S) | Saves the current report. You may accept the default name or save the report under another name. |
| <u>O</u>k (Alt-O) | Returns to the Spindle8 Checklist. |

Appendix A – The NORMIN Method (Bore and Spindle)

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.

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 27.

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.

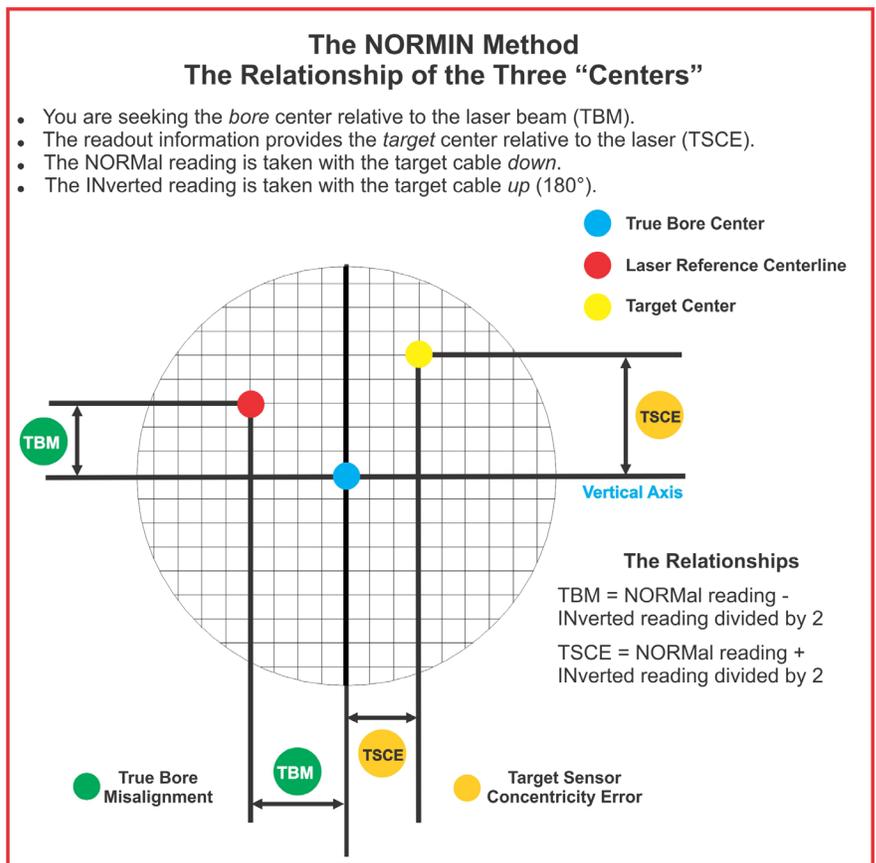


Figure 42 -- Three centers of bore alignment

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

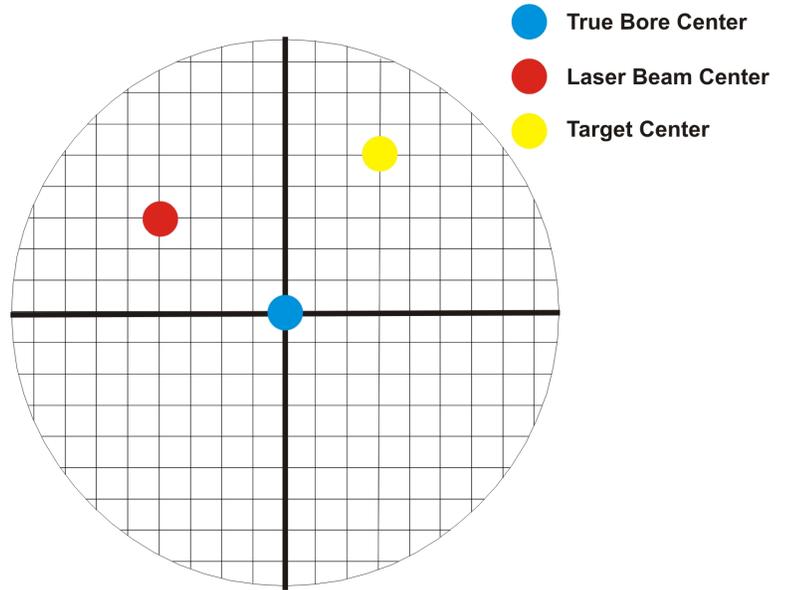


Figure 43 – Target in the NORMal position

Figure 44 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 44, the vertical readings are positive and the horizontal readings are negative. When the vertical TCE is calculated, (NORMal+INverted divided by 2) the Target Center is .004 in. higher and .003 in. to the right of the True Bore Center in the NORMal position.

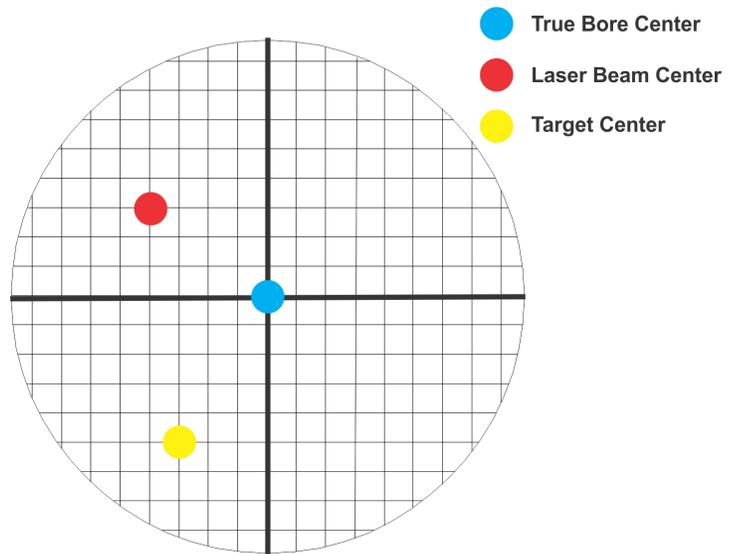


Figure 44 – Target in the INverted position

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

| | | | |
|------------------------------------|-------------------|--------------------------------------|-------------------|
| NORMal Vertical Reading | +0.002 in. | NORMal Horizontal Reading | +0.007 in. |
| INverted Vertical Reading | +0.008 in. | INverted Horizontal Reading | -0.001 in. |
| Total | +0.010 in. | Total | +0.006 in. |
| Divide by 2 = Vertical TSCE | +0.005 in. | Divide by 2 = Horizontal TSCE | +0.003 in. |

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 +0.005 in. and Horizontal +0.003 in.

Appendix B – Qualifying the Laser

Lasers must be qualified; that is, the beam must be centered and made parallel to the axis of rotation. This can be either the axis of the laser's mounting stud or of a spindle in which the laser is mounted.

All Hamar lasers are factory qualified to the mounting stud axis. Sometimes, due to slight mounting errors, it is desirable to adjust a laser so that it is aligned to the spindle's axis of rotation rather than to its own. A laser that has been qualified for a particular application may need to be re-adjusted for another, or back to its own axis. The following procedure is used to qualify the L-700 laser to a desired axis.

Warning!!
This procedure is for adjusting the laser only. While the software allows the user to adjust the target, targets are factory-qualified and need no field adjustments. Attempting to do so could potentially damage the target

The NORMIN Procedure

The NORMIN method is a way of canceling mounting errors. The word is a contraction of “NORMAl-INverted,” which briefly describes the method.

To take NORMIN readings, the laser and target fixtures are set in the NORMAl position (cable down) and the readings recorded. Then the target fixture is rotated 180 degrees to the INverted (cable up) position and a second set of readings obtained. The two sets of readings cancel out both laser and target center and angular mounting errors and provide a very accurate result.

For a detailed description of the NORMIN method, see Appendix A – *The NORMIN Procedure*, beginning on Page 29.

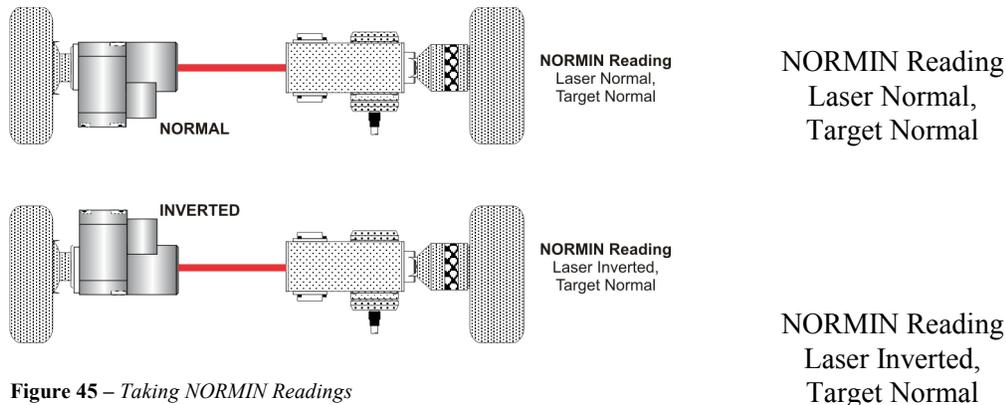


Figure 45 – Taking NORMIN Readings

Adjustments

The L-700 laser has centering and angular adjustments on the faceplate. The beam is emitted from the large hole in the center. The illustration below shows the location of the various adjustment screws.

Warning!!
Avoid direct exposure to the laser beam while adjusting the laser. Do not stare into the beam.

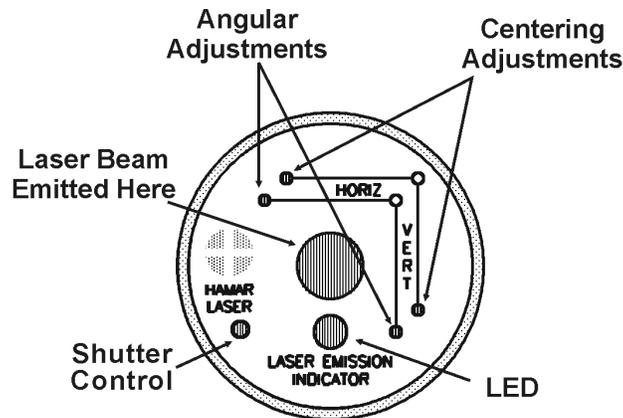


Figure 46 – Laser Adjustment Screws

Manual/Software-Assisted Qualification

To qualify a laser, error correction readings are taken to cancel out mounting and other errors and a set point is calculated. The laser beam is then adjusted to the set point, making it parallel to/coincident with the desired axis of rotation.

Manual qualifying requires the user to calculate the set point from the error correction readings before adjusting the laser to that point. A computer program, such as READ8, calculates the set point for the user, and zeroes the display at that point. The user then adjusts the laser beam to zero. While many users find the software-assisted method slightly easier, both procedures are essentially the same, and both will result in a qualified laser.

Hardware Requirements

The common equipment required to perform a qualifying procedure would be a target, an L-700 laser, and the spindle or fixture to hold the laser and target. To measure both the angle and center, a two-axis target with an angle module (the T-212) or a four-axis simultaneous target (such as the T-261A) is required. If the laser is being qualified to its own mounting stud axis of rotation, the recommended fixture is the Hamar Laser Model A-801 alignment/calibration fixture.

Each method also has its own additional requirements. The manual procedure requires a readout. The software-assisted procedure requires a computer and interface and Spindle8 or Read8 software.

Manual Qualifying Procedure

The following procedure explains how to qualify the laser with a four-axis target and a handheld readout. The best way to do this is to calculate set points for *angle* and adjust the laser angle first. The user then goes back and calculates the *center* set points and adjusts the laser centering.

Setup

1. Connect the target to the readout.

Plug the target into the readout and switch on the readout.

2. Set the laser and target in the spindle or fixture.

If qualifying to a spindle (or spindle mounting fixture), mount the laser in the spindle and the target in the master part. (If the beam does not strike the target cell while mounted in the spindle, move the spindle head until the readout window displays a reading and the "On-Target" light is on.)

If qualifying the laser to its own mounting stud axis, mount the laser and target facing each other in the A-801 calibration fixture.

Adjusting the Laser Angle

1. INvert the laser with the target in the NORMal position.

Set the laser in the Inverted (cable up) position, with the target in the NORMal (cable down) position and wait for the readings to stabilize (approx. 10 seconds). Write down the angular INverted reading.

2. Rotate the laser to the NORMal position.

Rotate the laser to the NORMal (cable down) position, with the target still in the NORMal position, and wait for the readings to stabilize (approx. 10 seconds). Write down the angular NORMal reading.

3. Calculate set points for each axis.

Calculate the set points for each axis--vertical and horizontal angle--with the following formula:

$$(\text{NORMal reading} + \text{INverted reading}) / 2 = \text{Set Point}$$

If, for example, the following vertical NORMIN readings are taken:

NORMal = .0021, INverted = -.0017, the equation would read:

$$[(.0021) + (-.0017)] / 2 = (.0004) / 2 = \mathbf{.0002}$$

In this case, .0002 would be the vertical angular set point. Use the two vertical angular readings to calculate the set point for vertical angle. The horizontal angle set points would be calculated in the same way.

4. Adjust vertical and horizontal angle to set points.

Adjust the angle using the angular controls on the laser's faceplate until the readout displays the calculated set points.

Adjusting the Laser Centering

1. INvert the laser with the target in the NORMAl position.

Set the laser in the Inverted (cable up) position, with the target in the NORMAl (cable down) position, and wait for the readings to stabilize (approx. 10 seconds). Write down the center INverted reading.

2. Rotate the laser to the NORMAl position.

Rotate the laser to the NORMAl (cable down) position, with the target still in the NORMAl position, and wait for the readings to stabilize (approx. 10 seconds). Write down the center NORMAl reading.

3. Calculate set points for each axis.

Calculate the set points for each axis--vertical and horizontal center--with the following formula:

$$(\text{NORMAl reading} + \text{INverted reading}) / 2 = \text{Set Point}$$

If, for example, the following horizontal NORMAl readings are taken:

NORMAl = -.0014, INverted = -.0006, the equation would read:

$$[(-.0014) + (-.0006)] / 2 = (-.0020) / 2 = \mathbf{-.0010}$$

Thus, in this case, -.0010 would be the horizontal center set point. Use the vertical center readings to calculate the set point for vertical centering. The horizontal center set points would be calculated in the same way.

4. Adjust vertical and horizontal center to set points.

Adjust the center using the centering controls on the laser's faceplate until the readout displays the calculated set points.

Checking Results

To confirm the results, invert the laser. The display should show the *same reading, same sign* (+ or -) as it did in the normal position, to within .0002 in. in the calibration fixture (results may be slightly less accurate in a spindle due to bearing runout). If the results are not close enough, recalculate the set points and readjust the laser unit.

The user should get as close to a zero difference on the readout as possible; however, in some fixtures or applications this may not be practical. If there is any doubt about consistency of results, check the repeatability of the fixture using the REPEAT function of the Read8 software. This will establish a tolerance within which the user can work.

Appendix C – Target Calibration

Before a new target can be used, it should be calibrated. If the target is purchased as part of a system, it will be calibrated at the factory and the resulting calibration factors will be included with the target.

If the user wants or needs to calibrate a target, the process involves moving or tilting a target a known amount from center or zero and observing the actual readings. The calibration factors are then calculated and used by the software to adjust the actual target reading to match the actual target displacement.

Four calibration factors (+V, -V, +H, -H) must be set for each two-axis target. A four-axis target (T-261, T-266, T-267 and T-212) requires eight factors (+V, -V, +H, -H, for center *and* for slope). Calibration factors may be entered manually, or calibration may be done automatically by the program.

Calibration Setup

1. Mount the laser and target.

Note: Figure 47 shows the target mounted in the Hamar Laser A-807 fixture stand. In order to take advantage of the automated calibration features available with the Read8 software, this fixture stand must be used for calibrating center and slope targets. Mount the laser in the non-adjustable hole on the fixture. Mount the target in the tilt plate with both the target and laser in the normal position (cord down).

An appropriate target stand with micrometer stage, such as the Hamar Laser T-230, or any calibrated x-y slide may be used when calibrating center-only targets (see Figure 48).

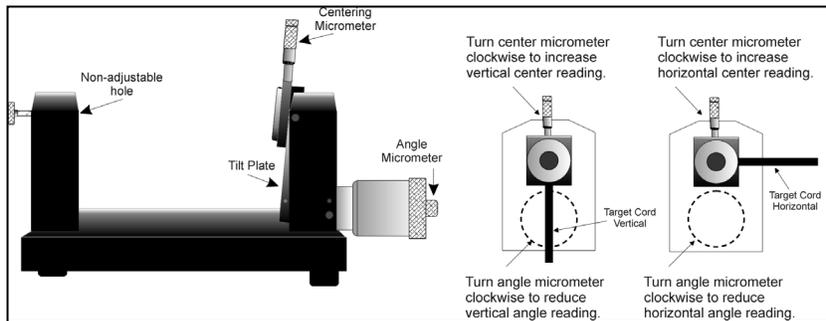


Figure 47 – Model A-807 Calibration Mounting Fixture

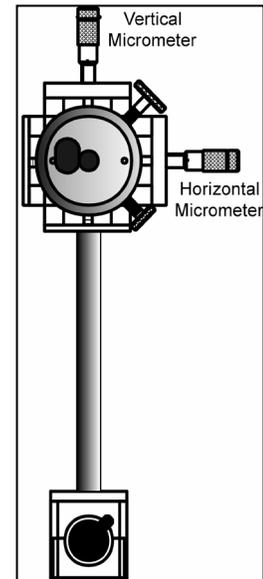


Figure 48 – T-230 Target Stand

2. Check all connections.

Connect the target to the interface, making note of the port to which it is connected, and make sure the interface is connected to the computer. Turn on the laser's power supply.

3. **Start the Read8 program and select Target Setup from the Setup Screen.**

Click the **New Target** button. The New Target screen displays (see Figure 49). Click the down arrow (↓) next to the **Type** list box to see a list of targets. Select the target you want to add. You may enter a new name for the target and the target serial number.

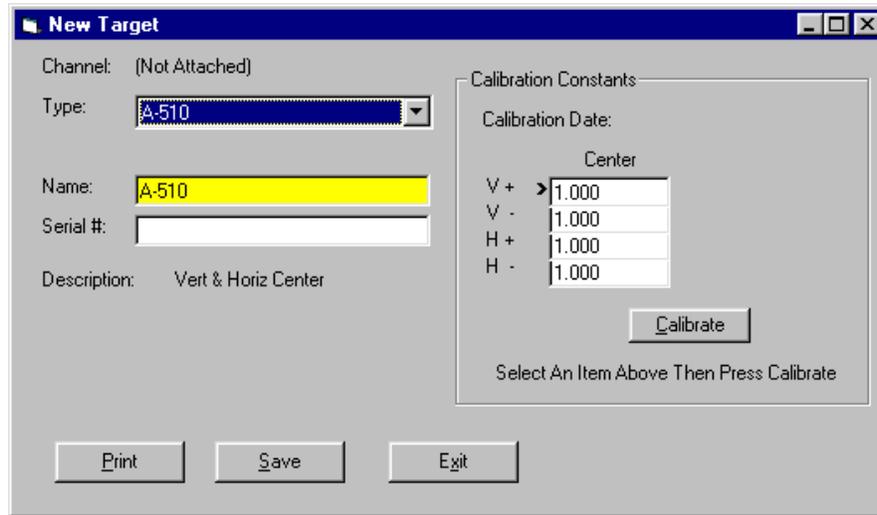


Figure 49 – New Target Screen – 2-axis Target

4. **Select the calibration factor from the list in the Calibration Constants menu, (+V, -V, +H, -H) then click the Calibrate button or Press Alt-C.**

Note: The preferred procedure is to calibrate the vertical axes, both center and slope if appropriate, then rotate the target in the fixture 90 degrees and calibrate the horizontal axes (see Figure 47). If working with a fixture that has a horizontal micrometer, there is no need to rotate the target (see Figure 48).

The Select Channel/Port for Target menu displays (see Figure 50). Select the channel or the port to which the target is attached and click **OK**. The Calibration Screen displays and indicates the Port or Channel selected (see right arrow in Figure 51).

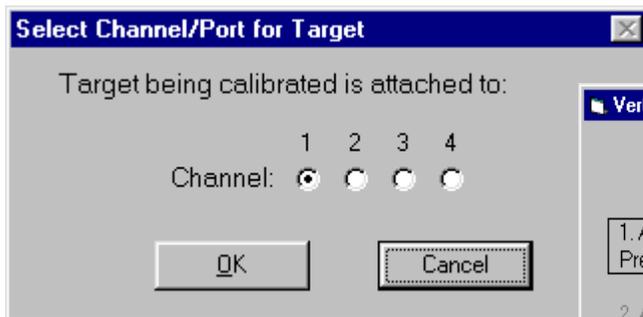


Figure 50 – Channel/Port Selection Screen

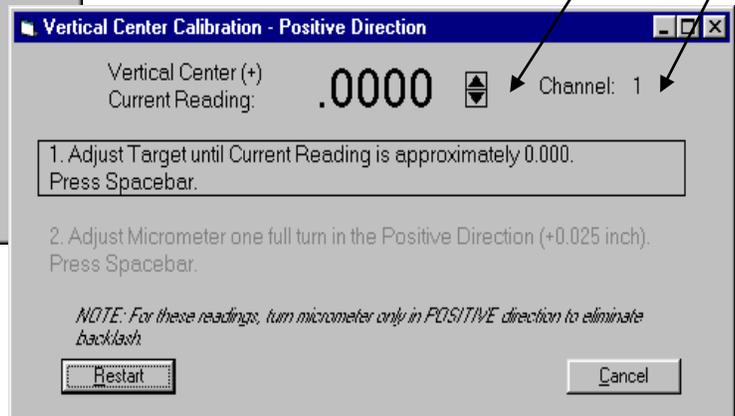


Figure 51 – Calibration Screen

Notes:

- Once the first calibration factor is recorded, the program adds the calibration date to the Calibration Constants screen.
- The double arrows next to the reading are visible only in Manual Data mode and are not available when actual targets are being read (see left arrow in Figure 51).
- Ensure that you perform each step slowly so that the values have time to register correctly before you press the spacebar.

Calibrating a Center-Only Target

- 1. For the first reading, (in this case V+), center the target using the centering micrometer. This corresponds to Step 1 on the Calibration Screen (see Figure 51).**

The display should read close to 0.000 (within ± 0.005 in.). Center in such a way as to remove the micrometer backlash; that is, for a *positive* calibration reading, approach zero from a *negative* reading by adjusting the micrometer in a positive direction.

- 2. Press the spacebar to record the reading.**
- 3. Read the micrometer on the selected axis and move it exactly .025 in., (one full turn) moving in the same direction as Step 1. This corresponds to Step 2 on the Calibration Screen.**

The displayed reading should be close to +.025 for the positive factors and close to $-.025$ for the negative factors.

- 4. Press the spacebar to record the reading.**

- 5. Re-zero the target.**

Turn the micrometer .025 inches (one full turn) in the direction *opposite* that in Step 3. You are now ready to record the next calibration factor.

Note: If using the Model A-807 Calibration Mounting Fixture, (see Figure 47) the target must be rotated 90° before performing a horizontal calibration. If the calibration fixture you are using has two centering micrometers, such as the T-230, the horizontal centering micrometer may be used and there is no need to rotate the target.

- 6. Select the next calibration factor from the Calibration Constants menu, and click the Calibrate button or Press Alt-C.**

Follow Steps 1-5 to obtain the next calibration factor. Repeat this procedure until all the necessary calibration factors have been obtained.

- 7. Save the calibration information.**

When the calibration procedure is completed, click the **Save** button to save the target profile. This target name will now display in the Select Targets to Use section of the Target Setup Screen.

Calibrating a Center-and-Slope Target

In order to use the automated features of the Read8 software, calibration for a center-and-slope target must be performed with the target mounted in the A-807 calibration mounting fixture (see Figure 47). This fixture is equipped with both a centering micrometer and an angle micrometer.

The Calibration Constants menu for center-and-slope targets requires that four calibration factors for center and four calibration factors for slope be entered (compare Figure 49 with Figure 52). The procedure is the same as that for calibrating a center-only target, however the calibration factors for slope are obtained by using the angle micrometer.

- 1. For the first reading, (in this case V+), center the target using the centering micrometer. This corresponds to Step 1 on the Calibration Screen (see Figure 51).**
 The display should read close to 0.000 (within ± 0.005 in.). Center in such a way as to remove the micrometer backlash; that is, for a *positive* calibration reading, approach zero from a *negative* reading by adjusting the micrometer in a positive direction.
- 2. Press the spacebar to record the reading.**
- 3. Read the micrometer on the selected axis and move it exactly .025 in. (one full turn), moving in the same direction as Step 1. This corresponds to Step 2 on the Calibration Screen.**
 The displayed reading should be close to +.025 for the positive factors and close to $-.025$ for the negative factors.
- 4. Press the spacebar to record the reading.**
- 5. Re-zero the target.**
 Turn the micrometer .025 in. (one full turn) in the direction *opposite* that in Step 3. You are now ready to record the next calibration factor.

Note: If using the Model A-807 Calibration Mounting Fixture, (see Figure 47) the target must be rotated 90° before performing a horizontal calibration. If the calibration fixture you are using has two centering micrometers, such as the T-230, the horizontal centering micrometer may be used and there is no need to rotate the target.
- 6. Select the next calibration factor from the Calibration Constants menu, and click the Calibrate button or Press Alt-C.**
 Follow Steps 5-9 to obtain the next calibration factor. Repeat this procedure until all the necessary calibration factors have been obtained. **Ensure that the calibration factors for slope are obtained by using the angle micrometer.**
- 7. Save the calibration information.**
 When the calibration procedure is completed, click the **Save** button to save the target profile. This target name will now display in the Select Targets to Use section of the Target Setup Screen.

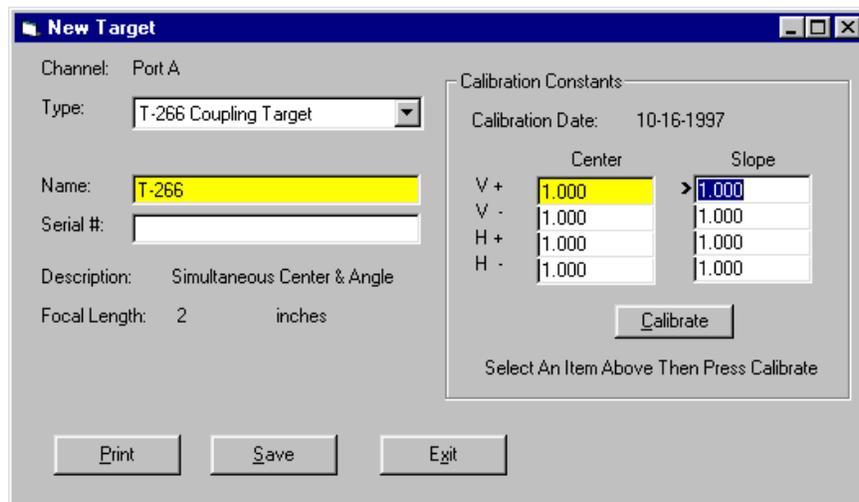


Figure 52 – New Target Screen – 4-axis Target

Appendix D –Troubleshooting Guide

| Problem | | Possible Solutions |
|----------|---|---|
| 1 | <i>No laser beam</i> | <ul style="list-style-type: none"> • Ensure laser is powered on and check switch. If LED on front of laser is dim, the battery is probably low. If LED is bright, diode has probably failed. • Ensure laser cover is open. • Replace battery. If the battery is new, ensure that it is inserted correctly. • Check for switch damage. |
| 2 | <i>Beam is not round (use white paper to see beam)</i> | <ul style="list-style-type: none"> • Clean laser optics with alcohol. • Ensure optics are not scratched or cracked. |
| 3 | <i>Beam has satellites (use white paper to see beam)</i> | <ul style="list-style-type: none"> • Clean laser optics with alcohol. • Ensure optics are not scratched or cracked. |
| 4 | <i>"---" shown in software target display</i> | <ul style="list-style-type: none"> • Software does not see the computer interface. Check target connections. • Check cable connections. • Ensure target is connected to R-358. • Ensure R-358 is fully charged. The R-358 takes 3-5 minutes to show a connection to the software when battery is fully charged. • Check connectors for broken pins or wires in connectors. • Ensure that ACTUAL TARGETS is selected under the DATA SOURCE tab in TARGET SETUP. • Check for kinks in the cables. • Extremely bright light shining on the face of the target may cause the display to go blank. |
| 5 | <i>OFF TGT shows in target display</i> | <ul style="list-style-type: none"> • Software sees the R-358 interface but not the target. • Check target connection. • Ensure target is connected to R-358. • Check connectors for broken pins or wires. • Check for kinks in the cables. • Ensure laser is powered on. • Ensure laser beam is bright (use white paper to see beam). • Ensure the beam is hitting the center of the target window. • Ensure the target angle is not too severe. The angular range of the T-261A is somewhat limited, so the angle of the target has to be within ± 0.5 degrees. |
| 6 | <i>Numbers in the target display "jump"</i> | <ul style="list-style-type: none"> • In TARGET SETUP, ensure that ACTUAL TARGETS (not RANDOM DATA) is chosen under the DATA SOURCE tab. |
| 7 | <i>Numbers in target display are noisy (jump up/down by more than 0.002 mm in 2 meters)</i> | <ul style="list-style-type: none"> • Check for vibration (turn off machine). • Check for warm or cold air (relative to ambient temperature) blowing between laser and targets. • Some A/C power chargers for laptops are noisy and can cause noise in the measurements. Try unplugging computer. • Check laser and target mounting setups to ensure tight clamp. • Increase data averaging in software. |

| | | |
|-----------|--|---|
| 8 | <i>Software crashes when loading</i> | <ul style="list-style-type: none"> • Ensure USB/serial converter cable is connected to the laptop. |
| 9 | <i>Either no negative or positive readings are displayed</i> | <ul style="list-style-type: none"> • Check for broken wires or pins pushed out of target connectors. If so, target will probably need repairs. • Ensure the screws on target connector are tightened on the R-358. |
| 10 | <i>Very odd results display</i> | <ul style="list-style-type: none"> • Possible corrupt targets.ini file (in Windows folder) or Hamar.ini (in Software32 folder). Rename both files. WARNING!! This will delete all target setup and calibration factors. • Make sure the screws on target connector are tightened on the R-358. |
| 11 | <i>Live readings do not display in Spindle8 Software</i> | <ul style="list-style-type: none"> • Open the Windows Control Panel and select the DISPLAY icon. Click the APPEARANCE tab. Ensure that the Color Scheme is set to DEFAULT (blue). |