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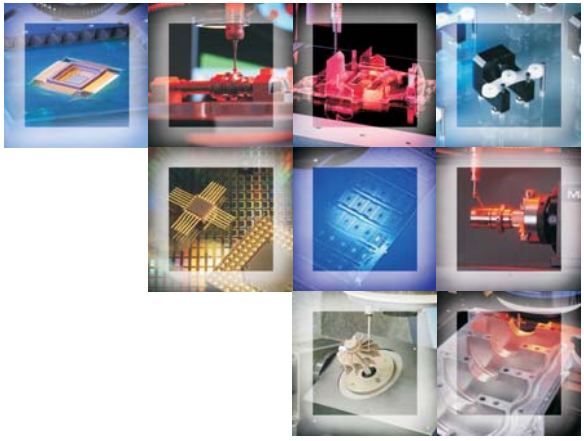

DRS Laser
Users Guide

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Optical Gaging Products, Inc. (OGP® company) warrants that the hardware and/or software will operate according to the specifications described in this manual and be free from known defects in materials or workmanship for a period of one year from the date of shipment. During this warranty period, OGP will, at its option, repair, replace or provide a work-around solution to any items that prove to be defective. In order to qualify for such warranty service, a complete description of the problem, with appropriate documentation (such as results, program listing, sample part and program) should be forwarded to OGP for our inspection. Such items will be returned to the customer if requested.

OGP does not warrant that the operation of the system software will be uninterrupted or error-free. This warranty does not apply to defects resulting from customer supplied or configured computer equipment, operating systems or software, unauthorized alteration or misuse, or operation outside the environmental specifications for the product.

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About This Guide

Welcome!

Optical Gaging Products (OGP) has produced this *Users Guide* as part of its ongoing effort to provide users with useful, comprehensive documentation. This document has been developed using standards and a design that enhances readability and makes it easier to find information.

We believe this manual will assist you in using the DRS laser effectively. If you should have any questions that are beyond this document's scope, please do not hesitate to contact your authorized OGP representative or OGP directly.

This manual applies to systems equipped with the Measure-X or MeasureMind 3D MultiSensor software.

Organization

The *DRS Laser Users Guide* contains the following sections:

CAUTION: Since this manual covers both Measure-X and MeasureMind 3D, be sure you are referring to the correct sections for your particular system. Headings with measurement software in parentheses mean that section is for that version of software only. Sections without measurement software in parentheses apply to systems with either metrology software.

About This Guide, (this section) describes the document's organization, lists documentation conventions, explains special symbols used in this document, and provides information regarding OGP technical support and customer service.

For Your Safety, provides an overview of necessary safety precautions to be observed whenever using or replacing a DRS laser.

Section 1, Introduction, provides a brief overview of the DRS laser and describes the different models and their location on the different measurement systems.

Section 2, Aligning the Laser, contains instructions on how to establish the laser to optics offset.

Section 3, Using the Laser, explains the different laser function in Measure-X and MeasureMind 3D, provides information concerning retractable lasers and describes the adjustable laser slide assembly.

Section 4, Viewing Surfaces, contains information related to the Surface windows in Measure-X and MeasureMind 3D.

Section 5, Extracting Features, describes the data extraction function in Measure-X and MeasureMind 3D.

Section 6, Replacing the Laser, contains instructions on how to replace one DRS laser with another and includes information about the laser configuration parameters.

Section 7, Maintaining the Laser, explains how to maintain the DRS laser.

Appendix A, Tutorials (Measure-X Systems), includes four tutorials designed to help you become more familiar with the functionality of the DRS laser on systems equipped with Measure-X

Appendix B, Tutorials (MeasureMind 3D Systems), includes four tutorials designed to help you become more familiar with the functionality of the DRS laser on systems equipped with MeasureMind 3D.

Appendix C, Unexpected Contact, explains what to do if your system is equipped with a retractable laser slide assembly and the laser encounters an obstruction.

Appendix D, Troubleshooting, is a brief guide to troubleshooting problems you may encounter when using the laser.

Who Should Read This Manual?

Read and familiarize yourself with this manual if you will be using the DRS laser on your metrology system.

Prerequisite Knowledge

Before using this manual, you should be familiar with the following:

- Routine use of your metrology system
- Routine use of the Measure-X or MeasureMind 3D MultiSensor software

Documentation Conventions

To help you locate, interpret, enter or select information easily, this document uses consistent visual cues and standard text formats. For example, capital letters (or upper-case letters) may be used to call attention to certain words and to help eliminate confusion and ambiguity. These documentation conventions are explained in the following table.

Type Style or Symbol	Used for	Examples and Explanations
Bold or italic	• Emphasized words	• Do **not** repeat this step • Select the *highest* magnification level
Bold, sans-serif typeface	• Commands to be typed • Keys to be pressed • Menu items to be selected • Buttons to be pressed	• Type **exit** • Type the following command, then press **Enter** • In the **System** menu, select **Reset** • Press the **Stop** button
⇒	• Pull-right menus	• In the **System** menu, select **Calibration** ⇒ **Linear**
Bold, all caps, sans-serif, centered typeface	• System message	**SELECT THE CORNER WITH THE LEFT MOUSE BUTTON.**
Initial caps	Proper nouns Product names Sections, figures	• Use the Measure function • SmartScope ZIP • See Section 3
All caps	Acronyms	• ASCII; OGP; DRS

Special Symbols Used in this Document

Throughout this document, you will find special information and symbols set apart from the body text as *Warnings*, *Cautions*, and *Notes*. These terms and symbols are explained below.

WARNING: Warns you of the possibility of personal injury when the laser is in use. Never look directly at the laser beam. Doing so could result in hazardous radiation exposure to your eyes.

WARNING: Warns you of the possibility of personal injury due to electrical shock when performing a task related to the DRS laser.

WARNING: Warns you of the possibility of other personal injury when performing a task related to the DRS laser.

CAUTION: Alerts you to the potential for damage to the DRS laser or your system when performing a task related to the DRS laser. Special instructions may be included for minimizing this risk.

Note: Provides additional information related to the topic being discussed.

Technical Support and Customer Service

OGP offers service and support contracts that are tailored to meet your specific needs and protect the value of your investment:

- **Hardware service contracts** for cleaning, general inspection, preventive maintenance and certification — includes a discount on replacement parts and emergency service labor rates
- **Software support contracts** with updates of software products, application assistance, and a discount on new software products.

For more information, call (585) 544-0400.

If You Need Help

If you need help with the operation or set up of the DRS laser, contact your local authorized OGP Sales Representative first. If he or she cannot help you, contact OGP directly. When you contact us, please have the serial number of your system and the version of Measure-X or MeasureMind 3D MultiSensor (as applicable) that you are currently using. The more information we have, the faster we can help you.

OGP can be reached:

- By phone at (585) 544-0400
- By FAX at (585) 544-8092 (Sales) or (585) 544-0131 (Service)
- By e-mail at *sales@ogpnet.com* or *service@ogpnet.com*
- On the Internet at http://www.ogpnet.com

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For Your Safety

Important: In addition to the laser safety information provided in this manual, we recommend that you review the safety information contained in the *Installation* and *Service and Maintenance* manuals for your system.

Laser Safety Guidelines

For your personal safety, please review the following laser safety guidelines. They are provided for your protection and apply to anyone who comes into contact with your machine. For more safety information related to your system, see the *Installation* and *Service and Maintenance* manuals for your system.

WARNING: Read the laser safety information carefully and follow all safety precautions. Not following safety precautions could result in hazardous radiation exposure to your eyes.

WARNING: Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

WARNING: The DRS laser should never be tilted or turned over while the laser indicator is lit.

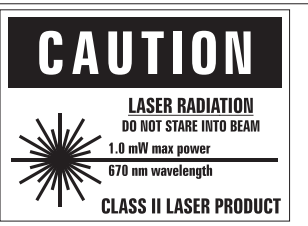
The DRS laser uses a laser diode as the laser source. DRS laser energy is not dangerous to exposed skin. However, if viewed directly or from a reflection of a specular (mirror-like) surface, the emitted light from those sources may be harmful to the human eye.

DRS lasers conform to laser safety regulations set forth by the Code of Federal Regulations 21 (CFR 21) and submitted to the Center for Devices and Radiological Health (CDRH). DRS lasers also conform to the IEC-825 (1993) laser safety regulations specified by the International Electrotechnical Commission (IEC).

DRS lasers meet Class II requirements of the CFR 21 standard (see safety label below) and Class 2 requirements of the IEC-825 European standard (see safety label below).

Laser Safety Markings

The following laser safety labels are attached to the DRS laser, and indicate compliance with CDRH and IEC-825 regulations.

Safety Label	Meaning
	**International Laser Symbol**
	**IEC-825 Laser Safety Classification**
	**CDRH Laser Safety Classification**
	**Laser Aperture Warning**

More Laser Safety Information

For more information on laser safety, contact the Laser Institute of America (*lia@laserinstitute.org*) and ask for ANSI specification number Z136.1-1993. The Laser Institute of America also offers other booklets and information on laser safety.

Section 1

Introduction

This section provides the following information:

- Overview of the DRS laser
- Difference between specular and diffuse surfaces
- Difference between specular and diffuse sensors
- Definitions of accuracy, standoff, capture range, and resolution
- DRS laser specifications
- DRS laser dimensions
- Laser features and functions
- Laser locations
- Assumptions and requirements

What is the DRS Laser?

The DRS (Digital Range Sensor) laser adds multi-sensor capability to certain OGP video measurement systems. DRS lasers are laser measuring devices, that use an internal sensor to measure surface heights. By moving the DRS laser over a surface, a high resolution profile is generated. The DRS laser can also be used as an alternative focus method.

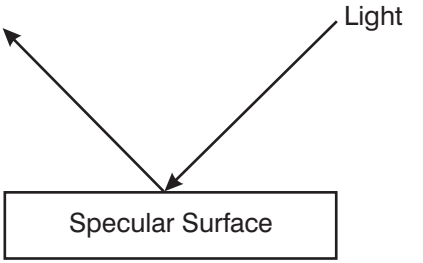
For multi-sensor video systems that support the DRS laser option, there are three models available: DRS-300, DRS-500, and DRS-2000.

Note: Contact your local authorized OGP representative or call the OGP Sales Department at (585) 544-0400 for information on what DRS laser models are available for your system.

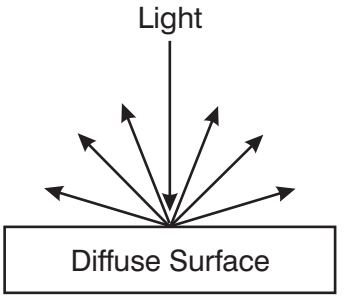
Surface Types

The difference between specular and diffuse surfaces are discussed below.

- **Specular** surfaces are reflective, polished, and glossy. When the laser light strikes a specular surface, the light's angle of reflection is equal to the angle of incidence.



- **Diffuse** surfaces are typically non-polished. When the laser light strikes a diffuse surface it is reflected in multiple directions.



Sensor Types

There are two types of DRS lasers.

Figure 1-1. Specular Sensor

- **Specular Sensor:** This sensor is ideal for profiling surfaces that are relatively flat, reflective, polished, and glossy, in other words where the light's angle of incidence is equal to the angle of reflection. The laser light strikes the surface at a 35° angle from normal and is reflected at a 35° angle toward the sensor as shown in Figure 1-1. Specular sensors also work on diffuse surfaces, which makes them a good general purpose device. DRS-300 and DRS-500 lasers are the specular type.

Figure 1-2. Diffuse Sensor

- **Diffuse Sensor:** This sensor is ideal for profiling surfaces which scatter light in random directions. Such surfaces are typically rough and non-polished. The laser light strikes perpendicular (normal) to the surface and the light that is scattered at a 35° angle, strikes the sensor as shown in Figure 1-2. Smooth surfaces may not scatter light at a 35° angle, making the diffuse sensor inappropriate. DRS-2000 lasers are the diffuse type.

Sensor Terminology

The following terms are used to describe a DRS laser.

- **Accuracy** - calculated as the difference between the measured value and the stated value of a certified traceable QVI laser step target.
- **Standoff** - the distance in Z from the lowest point on the DRS laser to the middle of the capture range.
- **Capture Range** - the maximum height difference that the sensor can measure from a fixed position.
- **Resolution** - the smallest height difference that the sensor can measure.

The DRS laser model number is the sensor's capture range in microns. For example, the DRS-300 has a capture range of 300 microns.

Typically, sensor capture range and resolution are inversely related. When a laser has high resolution, it has a small capture range. For example, the DRS-300 is a high resolution laser (0.125 microns), but only over a small range (300 microns.) In contrast, the DRS-2000 has a large capture range (2000 microns), but has less dynamic resolution (1.0 micron).

Specifications

This table lists the specifications for the three different DRS models.

Specification	DRS-300	DRS-500	DRS-2000
Sensor Type	Specular	Specular	Diffuse
Capture Range	300 µm	500 µm	2000 µm
Z Accuracy within Capture Range	1.0 µm	1.0 µm	10 µm
Dynamic Resolution	0.125 µm	0.125 µm	1.0 µm
Standoff Distance	17 mm	17 mm	31.5 mm
Triangulation Angle	70°	70°	35°
Spot Size	7-12 µm	16-23 µm	32-48 µm

Note: Contact your local authorized OGP representative or call the OGP Sales Department at (585) 544-0400 for information on what DRS laser models are available on your system.

Dimensions

The dimensions for the DRS-300 and DRS-500 are shown in Figure 1-3, and the dimensions for the DRS-2000 are shown Figure 1-4 .

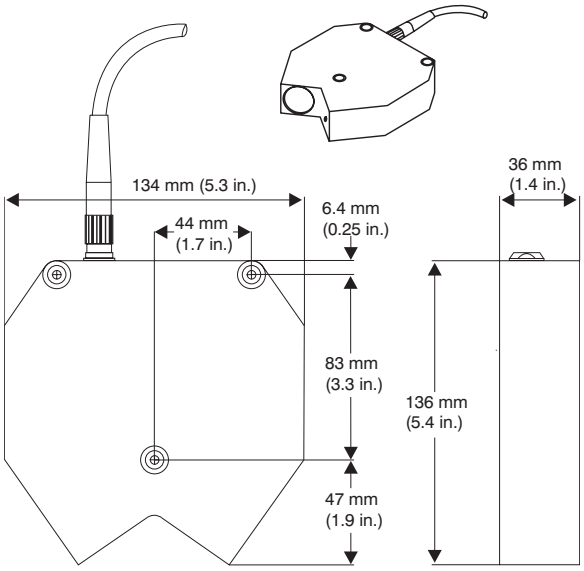


Figure 1-3. DRS-300 and DRS-500 Dimensions

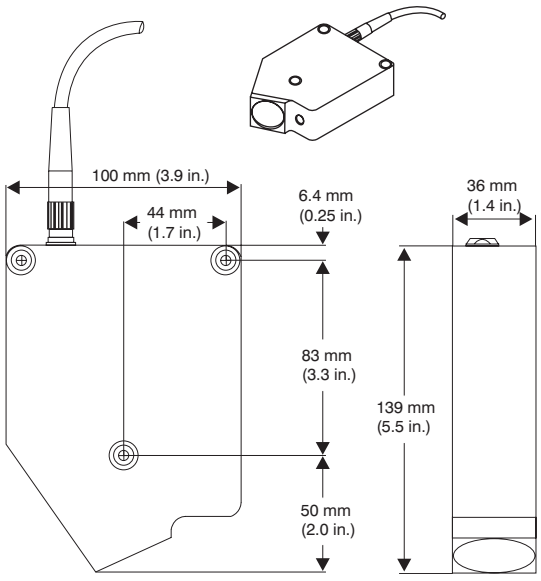


Figure 1-4. DRS-2000 Dimensions

The features of the DRS laser are displayed in Figure 1-5, and the function of each feature is described in the table on the following page.

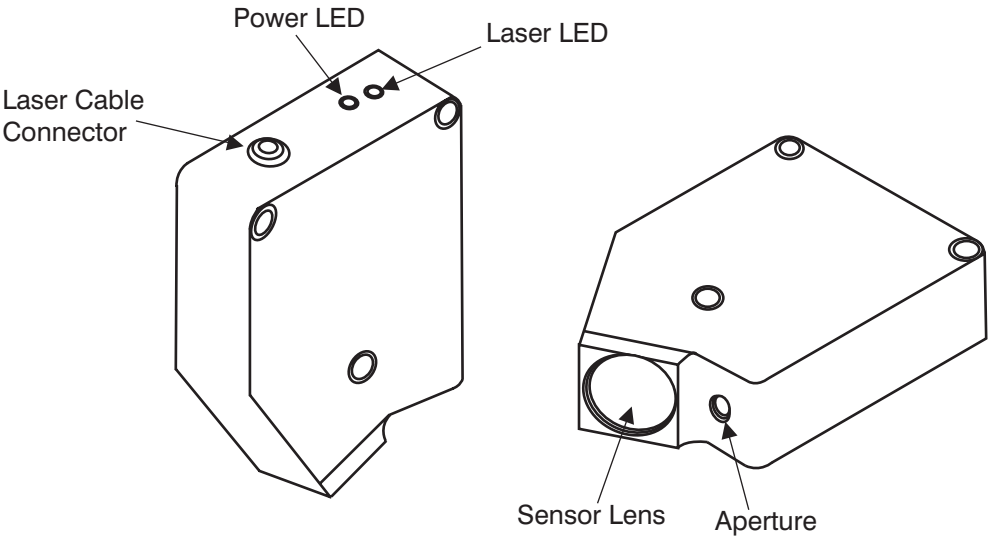


Figure 1-5. DRS Features

Feature	Function
Laser Cable Connector	Connects the laser to the video system via the laser cable
Laser LED (see note)	Indicates the status of the laser
Power LED	Indicates when power is available to the laser
Aperture	Laser light source; **Do not stare into the beam**
Sensor Lens	Collects the laser light that is reflected at 35° from the surface

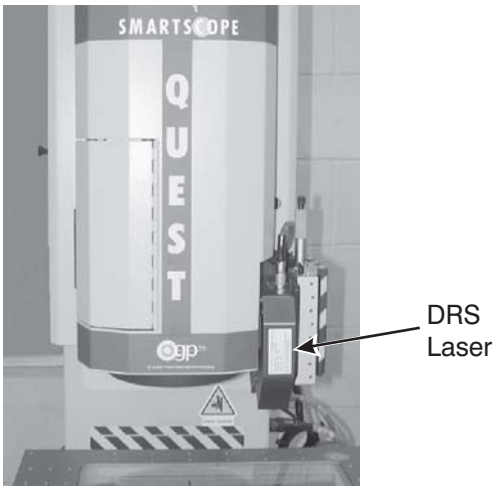
Notes:

1. On some systems the Laser LED on the laser may not be visible. This is especially true of the SmartScope Quest/Vantage floor model and Avant Apex systems, where the DRS laser is mounted directly behind the optical assembly.
2. In addition to the Laser LED on the laser, your system may have a blue Laser Indicator LED on the Z axis cover, which is identified by the universal laser symbol. This LED lights a constant blue to indicate that the laser is on, and flashes to indicate that the laser is taking height measurements.

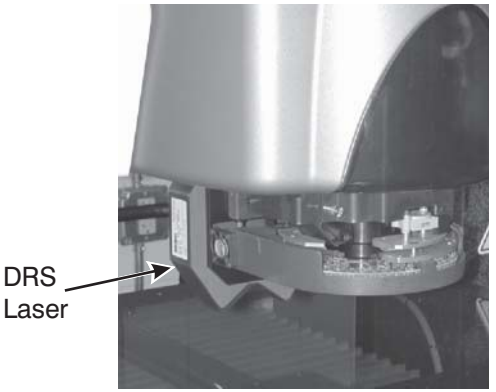
Mounting Locations

The mounting locations for the DRS laser varies by system, as described and illustrated below and on the following page.

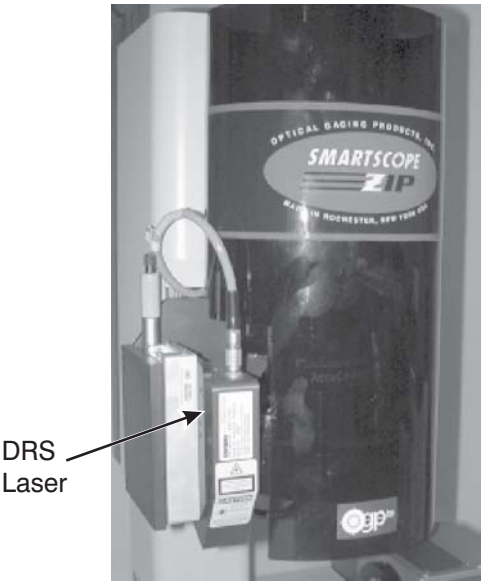
- On SmartScope Quest/Vantage 250 zoom lens systems, the laser is mounted to the right of the optical assembly.



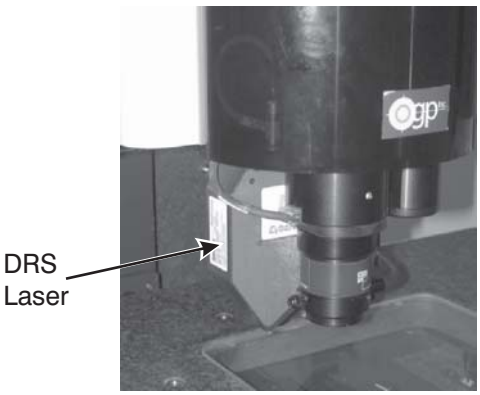
- On SmartScope Quest/Vantage 450, 600, and 650 systems, the laser is mounted directly behind the optical assembly.



- On SmartScope/Avant ZIP, Avant ATS, and SmartScope Quest/Vantage 250 fixed lens systems, the laser is mounted to the left of the optical assembly.



- On Avant Apex systems, the laser is mounted directly behind the optical assembly.



Assumptions and Requirements

- Your system is currently equipped with a DRS laser. If your system is not equipped with a DRS laser and you would like it to be, please contact your local authorized OGP representative or call the OGP Sales Department at (585) 544-0400.
- You know how to use the MeasureMind 3D MultiSensor or Measure-X software (as applicable).
- You are able to operate your SmartScope Flash, SmartScope/Avant ZIP, SmartScope Quest/Vantage, or Avant Apex/ATS system.

Note: The DRS laser functionality described in this manual is available in Measure-X, software Revision 2.x.x or higher, and MeasureMind 3D MultiSensor, software Revision 12.55.x or higher.

Section 2

Aligning the Laser

This section outlines the procedures to align the laser to optics offset.

It is necessary to establish the centerline offset from the laser to the optics before you can use the laser. The laser alignment procedures calibrate the laser to optics offset.

You should perform the laser alignment procedures on a regularly scheduled basis for optimum system results.

Both alignments (rough and fine) can only be performed when there is no routine in memory and the calibration mode is enabled, as described in the *Calibration and Alignment Manual* for your system.

The procedure to align the laser to optics offset is done in two parts:

- Laser rough alignment
- Laser fine alignment

Calibration Artifact

Both alignment procedures require a QVI square cutout reticle (P/N 526685) as a calibration artifact (see Figure 2-1). Please observe the following precautions whenever handling the calibration artifact:

CAUTION: Never touch the inside edges of the cutout section. The edges are extremely fragile and can be damaged easily.

CAUTION: If the cutout section of the reticle becomes dirty, only use a can of oil-free pressurized air to clean it. If you are unable to remove the dirt, please contact the OGP Service Department for further instructions.

Figure 2-1. Calibration Artifact

Aligning the Laser (Measure-X Systems)

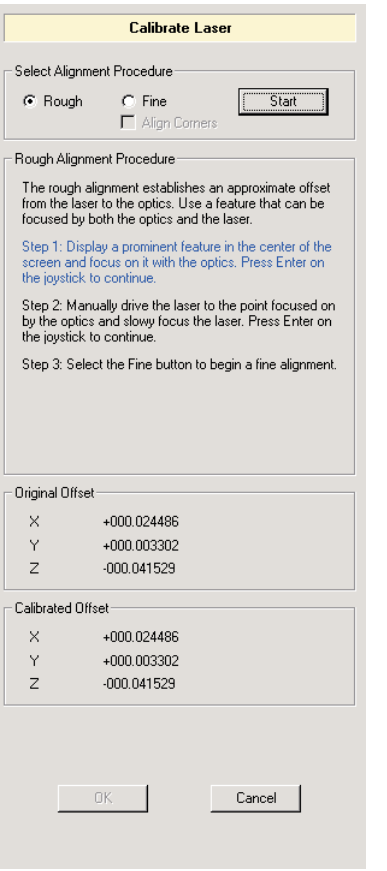
This subsection describes how to align the laser to optics offset on systems equipped with the Measure-X software. The alignment procedures for MeasureMind 3D systems is described on page 2-9.

Laser Rough Alignment (Measure-X Systems)

The Laser Rough alignment is the first part of the alignment process. It establishes an *approximate* offset from the laser to the optics.

Follow the steps below to perform the Laser Rough alignment on a system equipped with the Measure-X software.

1. Power up the software, and allow the system to warm up for at least 15 minutes.
2. Make sure that the entire stage is clear, because the stage will move during this procedure.
3. Align and secure the calibration artifact (P/N 526685) squarely on the stage to prevent it from moving during the alignment procedure.
4. In the **System** menu, select **Calibration ⇒ Sensor Align ⇒ Laser to Optics.**
   - The software displays the Calibrate Laser window over the toolbox.
5. Select the **Rough** radio button, and then click **Start**.
   - The software displays a Focus tool and instructions to display a feature that can be focused both by the laser and the optics.



6. Using the joystick, move the stage so that the image of the calibration artifact is in the center of the screen, adjust the illumination if needed, and focus on the surface. We recommend that you **focus at high magnification**. For example, focus on the surface near the open area of the lower-left corner of the calibration reticle, see Figure 2-2 and Figure 2-3.

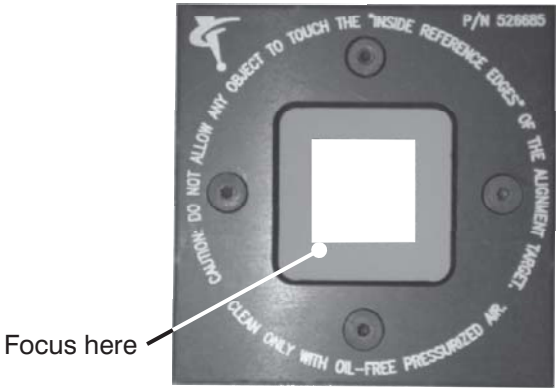


Figure 2-2. Focus Point on Calibration Artifact

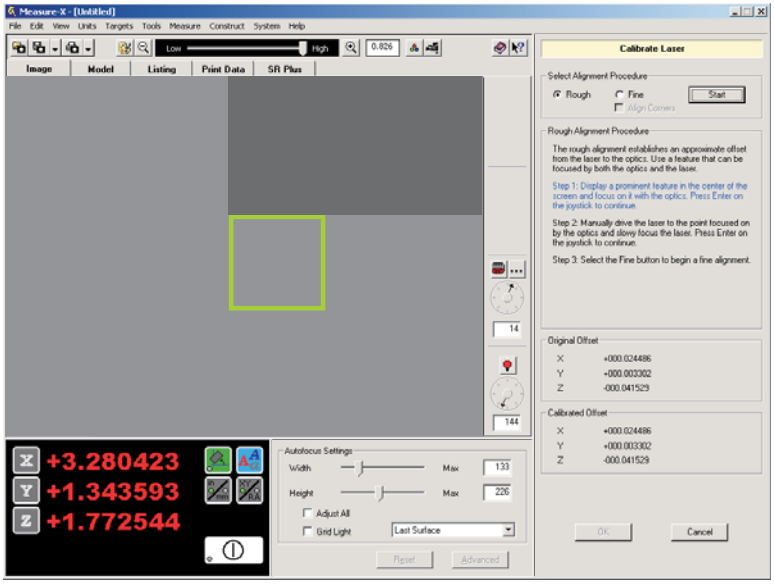


Figure 2-3. Focusing on the Surface of the Calibration Artifact

7. Press **Enter** on the joystick.

   - The software accepts the entered point, turns on the laser (a red blinking dot is visible on the surface of the calibration artifact and the blue Laser Indicator LED starts blinking), and displays the laser sensor graph.

Note: If your system is equipped with a retractable laser and it is docked, the software will display a prompt to deploy the laser before measuring laser points. Click **Yes** in response to the prompt.

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8. Drive the laser to the same location where you optically focused on the feature in Step 6 (observe the red laser spot on the feature).

CAUTION: Avoid contact between the laser and calibration artifact while focusing the laser.

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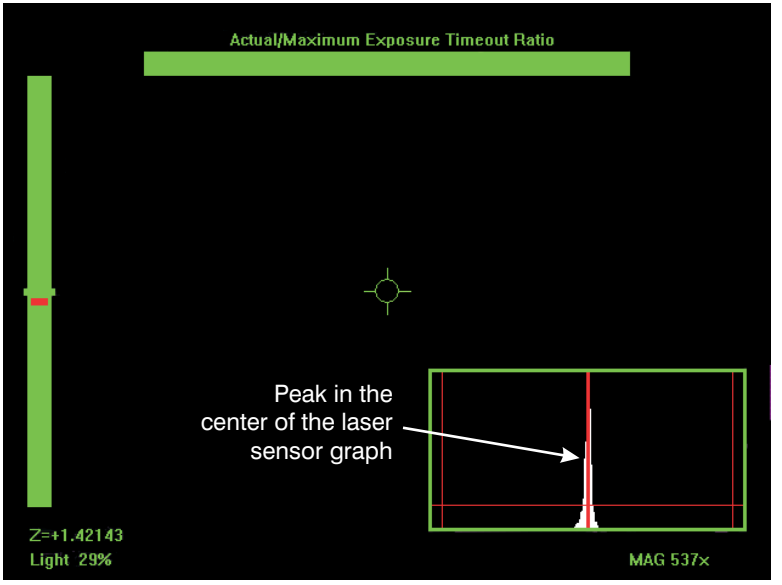
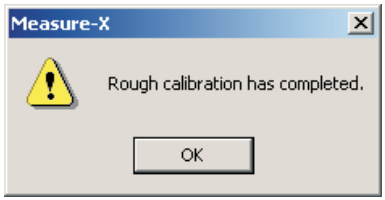
9. Slowly adjust the focus by twisting the joystick knob so that the peak is in the center of the sensor graph, as shown in the illustration below.

Note: When you adjust the laser focus with specular lasers, the laser spot will move.



10. Verify that the laser spot is in the same location where you optically focused on the feature in Step 6. If necessary, reposition the laser along the X and/or Y axis so that the laser spot is in the correct location.

11. Press **Enter** on the joystick. The software accepts the laser focus point and displays the following dialog box:



12. Click **OK**.

This completes the Laser Rough alignment procedure for systems equipped with Measure-X.

- The software activates the **Fine** radio button so you can begin the Laser Fine alignment. Go to Step 4 of the next procedure.
- The OK button is not activated unless the software has done a fine alignment at least once. When you click OK (if active) or Start to begin the fine alignment, the data from the rough alignment is put in the LASER.INI file.

Laser Fine Alignment (Measure-X Systems)

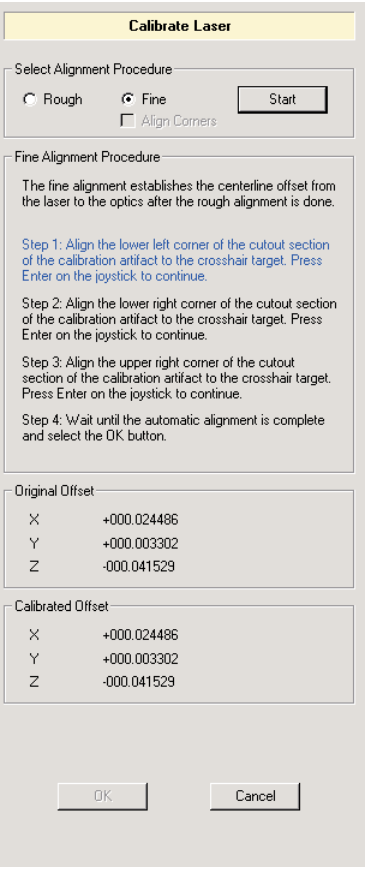
This procedure establishes the centerline offset from the laser to the optics *after* the laser rough alignment (described previously) has been completed.

Note: This procedure should be performed at high magnification.

Follow the steps below to perform the Laser Fine alignment on a system equipped with the Measure-X software. If this is being done immediately after the laser rough alignment, skip Steps 1 through 3.

1. Make sure the entire stage is clear because the stage will move during this procedure.
2. Align and secure the calibration artifact (P/N 526685) squarely on the stage to prevent it from moving during the alignment procedure.
3. In the **System** menu, select **Calibration** ⇒ **Sensor Align** ⇒ **Laser to Optics**.

   The software displays the Calibrate Laser window over the toolbox.
4. Select the **Fine** radio button.
   - The software displays the crosshair target and instructions to align the lower-left corner of the cutout to the target.
5. Using the joystick, move the stage so that the lower-left corner of the cutout is displayed in the center of the Image window.
6. Twist the focus knob on the joystick until the corner is in best focus.
7. Click **Start**.



8. Align the *lower-left* corner of the cutout section to the Crosshair target (see Figure 2-4) and press **Enter** on the joystick. The software accepts the entered point.

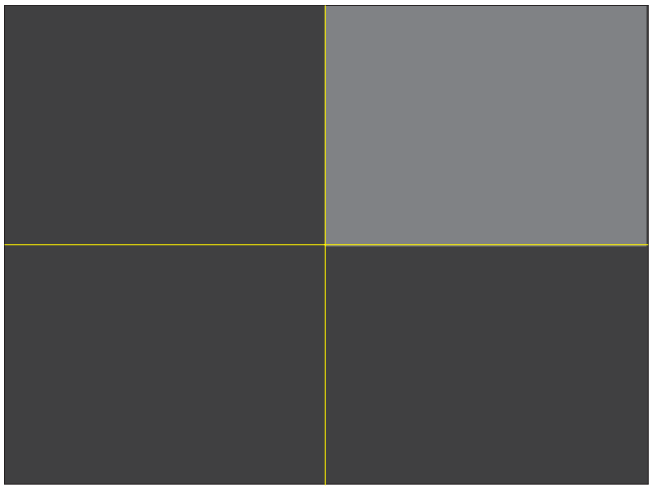


Figure 2-4. Aligning the Lower-Left Corner of the Cutout

9. Using the joystick, move the stage so that the lower-right corner of the cutout section is displayed in the center of the Image window.
10. Align the *lower-right* corner of the cutout section to the Crosshair target (see Figure 2-5) and press **Enter** on the joystick. The software accepts the entered point.

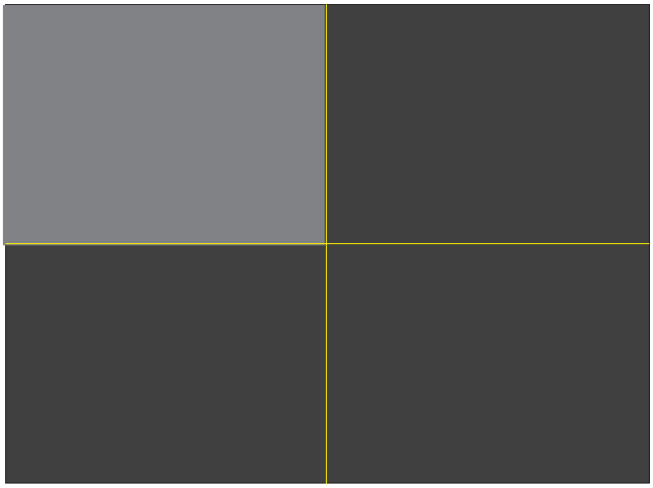


Figure 2-5. Aligning the Lower-Right Corner of the Cutout

11. Using the joystick, move the stage so that the upper-right corner of the cutout section is displayed in the center of the Image window.
12. Align the *upper-right* corner of the cutout section to the Crosshair target (see Figure 2-6) and press the **Enter** button on the joystick.

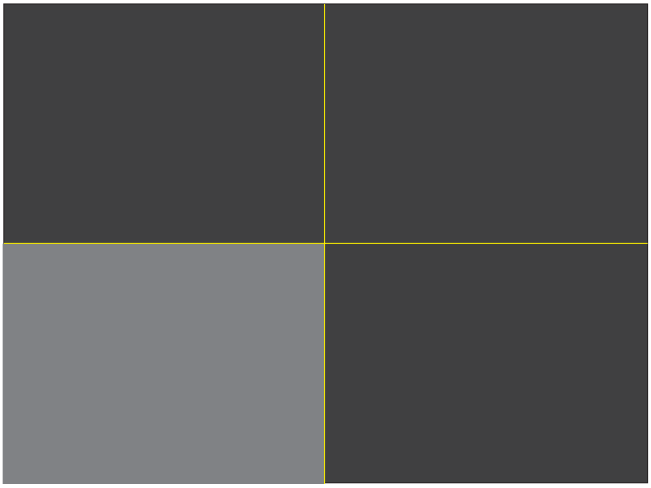


Figure 2-6. Aligning the Upper-Right Corner of the Cutout

- The software begins to automatically measure points optically around the edge of the square cutout at predetermined offsets to establish known optics locations. This is done using the Strong Edge tool. Then the software drives the laser and performs laser scans at the same locations. This takes approximately 3 to 5 minutes.
- When the software is done measuring the edges, it automatically measures four optical and laser focus points near each of the corners. Each point is measured 5 times with the optics and 10 times with the laser.
- After the laser fine alignment is completed, the software displays both the original offset (from the last calibration) and the new offset in the Calibrate Laser window, and a prompt indicating that the calibration is complete.

13. Click **OK** in response to the prompt.
14. In the Calibrate Laser window, click **OK**. The software saves the new offsets in the LASER.INI file.
    - The software enables the Align Corners check box after at least one loop of the laser fine alignment has been completed. You need to check the box only if you have moved the alignment reticle after an alignment.

This completes the laser fine alignment procedure for systems equipped with Measure-X.

Aligning the Laser (MeasureMind 3D Systems)

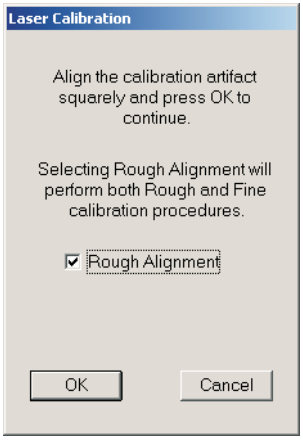
This subsection describes how to align the laser to optics offset on systems equipped with the MeasureMind 3D software. The alignment procedures for Measure-X systems is described on page 2-2.

Laser Rough Alignment (MeasureMind 3D Systems)

The Laser Rough alignment is the first part of the alignment process. It establishes an *approximate* offset from the laser to the optics.

Follow the steps below to perform the Laser Rough alignment on a system equipped with the MeasureMind 3D software.

1. Power up the software, and allow the system to warm up for at least 15 minutes.
2. Make sure that the entire stage is clear, because the stage will move during this procedure.
3. Align and secure the calibration artifact (P/N 526685) squarely on the stage, to prevent it from moving during the alignment procedure.
4. In the **System** menu, select **Calibration** ⇒ **Sensor Align** ⇒ **Laser to Optics.**
   - The software displays the following dialog box:



5. Select **Rough Alignment** and then click **OK**.
   - The software displays a Focus target and a prompt to display a prominent feature in the center of the screen and focus on it with the optics.
6. Click **OK** in response to the prompt.

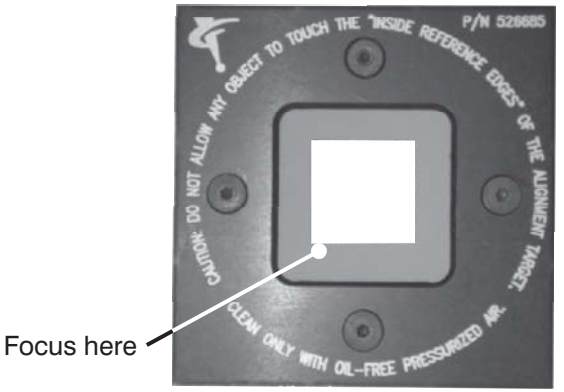


Figure 2-7. Focus Point on Calibration Artifact

7. Using the joystick, move the stage so that the image of the calibration artifact is in the center of the screen, adjust the illumination if needed, and focus on the surface. We recommend that you **focus at high magnification**. For example, focus on the surface near the open area of the lower-left corner of the calibration reticle, see Figure 2-7 and Figure 2-8.

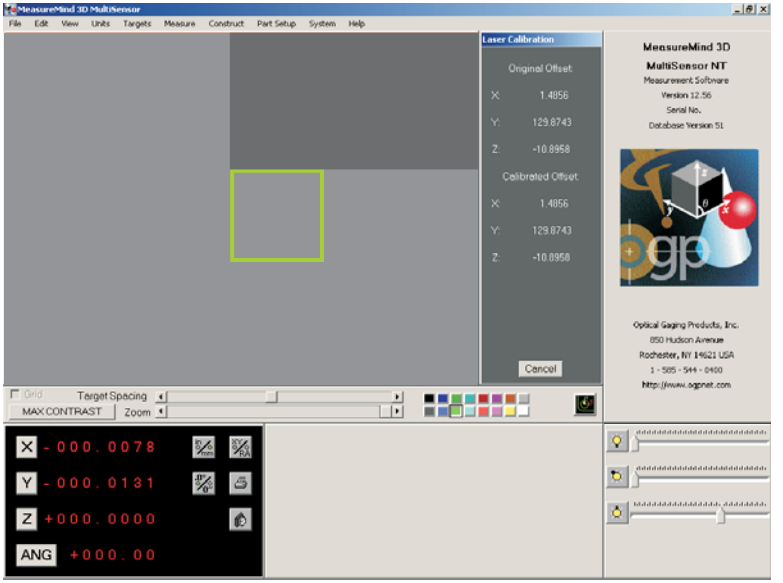


Figure 2-8. Focusing on the Surface of the Calibration Artifact

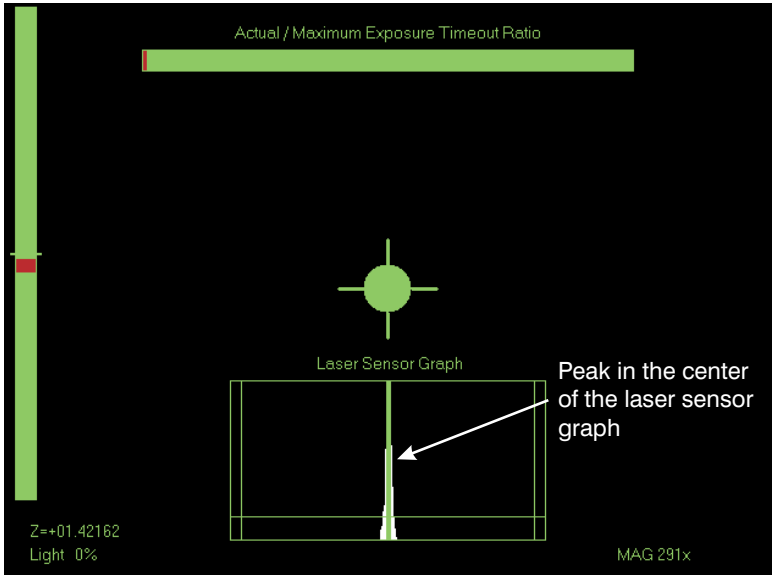
8. Press **Enter** on the joystick.
   - The software accepts the entered point, turns on the laser (a red blinking dot is visible on the surface of the calibration artifact and the blue Laser Indicator LED starts blinking).
   - If your system is equipped with a retractable laser and it is docked, the system displays a prompt to deploy the laser before measuring laser points. Click **Yes** in response to the prompt.
   - The system displays a prompt to focus the laser at the same location where you focused the optics.

9. Click **OK**.
   - The system displays the laser sensor graph.
10. Drive the laser to the location where you optically focused on the feature in Step 7.

CAUTION: Avoid contact between the laser and calibration artifact while focusing the laser.

11. Slowly adjust the focus by twisting the joystick knob so that the peak is in the center of the sensor graph, as shown below.

Note: When you adjust the laser focus with specular lasers, the laser spot will move



12. Press **Enter** on the joystick to accept laser focus point.
   - The system automatically starts the Laser Fine alignment procedure (described next) and displays the prompt shown on the following page.

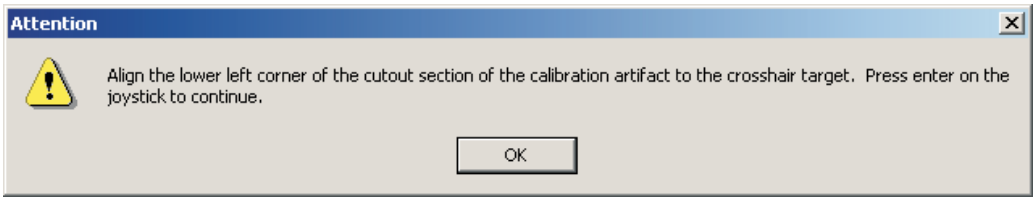
This completes the Laser Rough alignment procedure for MeasureMind 3D systems.

Laser Fine Alignment (MeasureMind 3D Systems)

This procedure establishes the centerline offset from the laser to the optics *after* the Laser Rough alignment (described previously) has been completed.

Note: The systems automatically starts the Laser Fine alignment after you complete the Laser Rough alignment.

After completing the Laser Rough alignment (described previously), the software displays the Crosshair target and the following prompt:



1. Click **OK** in response to the prompt and move the stage so that the lower-left corner of the cutout section is displayed in the center of the Image window.
2. Align the *lower-left* corner of the cutout section to the Crosshair target (see Figure 2-9) and press **Enter** on the joystick.

   The software accepts the entered point, immediately moves the stage so that the lower-right corner of the cutout section is displayed in the center of the Image window, and displays a prompt to align the lower-right corner.

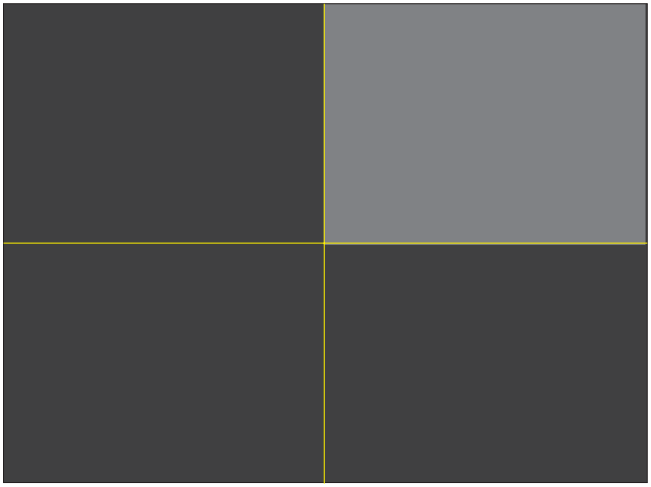


Figure 2-9. Aligning the Lower-Left Corner of the Cutout

3. Click **OK** in response to the prompt.

4. Align the *lower-right* corner of the cutout section to the Crosshair target (see Figure 2-10) and press **Enter** on the joystick.

   The software accepts the entered point, immediately moves the stage so that the upper-right corner of the cutout section is displayed in the center of the Image window, and displays a prompt to align the upper-right corner.

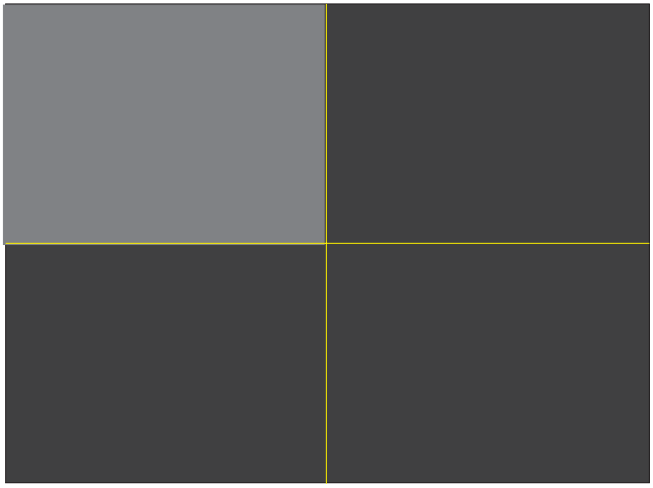


Figure 2-10. Aligning the Lower-Right Corner of the Cutout

5. Click **OK** in response to the prompt.

6. Align the *upper-right* corner of the cutout section to the Crosshair target (see Figure 2-11) and press **Enter** on the joystick.

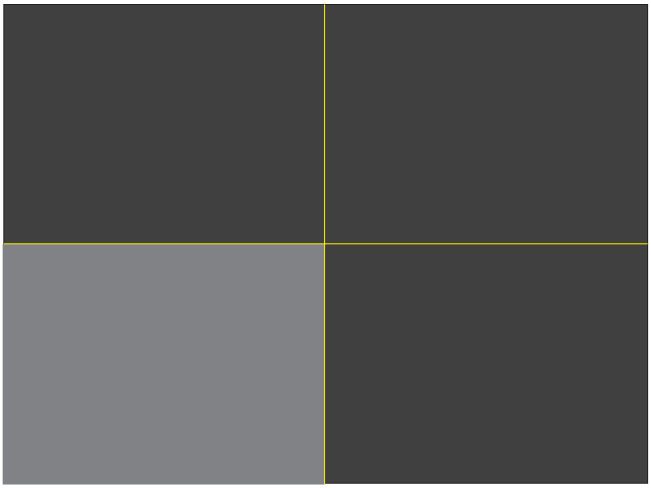


Figure 2-11. Aligning the Upper-Right Corner of the Cutout

The software begins to automatically measure points optically around the edge of the square cutout at predetermined offsets to establish known optics locations. This is done using the Strong Edge tool. Then the software drives the laser and performs laser scans at the same locations. This takes approximately 3 to 5 minutes.

When the software is done measuring the edges, it automatically measures four optical and laser focus points near each of the corners. Each point is measured 5 times with the optics and 10 times with the laser.

After the laser fine alignment is completed, the software displays both the original offset (from the last calibration) and the new offset in the Laser Calibration window. The software also displays a prompt, which asks you if you would like to improve the calibration; click on Yes to perform the fine alignment again, or click on No to end the calibration.

Note: By default, the software automatically performs the fine alignment three times after the initial loop in an effort to improve the alignment results.

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7. In the Measurement window, click **OK**. The software saves the new offsets in the LASER.CFG file.

This completes the Laser Fine alignment procedure for systems equipped with MeasureMind 3D.

Section 3

Using the Laser

This section describes how to use the DRS laser. The information in this section is presented in the following sequence.

- Using the laser in Measure-X (pages 3-1 to 18)
- Using the laser in MeasureMind 3D (pages 3-19 to 3-34)
- Retractable laser (page 3-35)
- Laser slide assembly (page 3-36)

Using the Laser Tool in Measure-X

This subsection describes how to use the Laser tool in Measure-X.

Note: See *Using the Laser Target in MeasureMind 3D* for information about using the DRS laser on systems equipped with MeasureMind 3D.

Laser Functions

The following laser functions are available on systems equipped with the DRS laser and Measure-X software:

- Use **Laser Focus** to focus a point on the surface of a part, e.g., to measure the Z axis position. The software "looks" at image data from several Z axis positions and calculates the Z axis position that yields the best laser focus, or highest contrast.
- Use a **Laser Scan** strategy to scan the surface of a part between specified points and produce a high resolution surface profile.

To activate the laser function click on the **Laser** icon in the toolbox or select **Laser** in the **Tools** menu.

Note: The accuracy of the laser is independent of magnification level. The optics can be anywhere within the zoom range when using the laser.

How to Use Laser Focus

Follow the steps below to measure a feature with the Laser Focus function.

1. Click the **Laser** icon in the toolbox or select **Laser** in the **Tools** menu to activate the laser function.
2. In the Laser Settings window, select **Focus** in the Strategy list (described on page 3-5). The software displays the Laser Focus target, which appears as a circle with crosshairs in the center of the Image window.

3. If you want to change the advanced laser settings or view the sensor graph, click **Advanced** and make the desired changes (see page 3-9 for more information).
4. Select the desired Measure function to measure the feature, e.g., Plane.
5. Display the feature inside the circle and make sure the image is optically focused. If it is not, focus the image manually by rotating the Z axis fine adjustment knob on top of the joystick or use a Focus tool.
6. Click on the feature to be measured (outside the laser target) to bring it inside the laser target.

WARNING: To prevent hazardous radiation exposure to your eyes, do not look directly at the laser beam while operating the laser.

7. Click **inside the circle** to perform the laser focus. The system moves the laser to the optics location, turns off the video illumination, performs the laser focus (which is indicated by a flash of the blue Laser Indicator LED), and obtains a focus point.
   - If it is not successful on the first attempt, it will continue trying in increments of 90% of the capture range for the number of attempts specified in the LASER.INI file. In this case, it moves the stage in the second attempt, depending on the configuration settings.
   - If it fails, twist the joystick knob until the focus is within range and click inside the laser target to perform the focus manually. If you wish, you can also use the sensor graph (described on page 3-14).
   - If you place the cursor outside the circle and click the left mouse button, the system moves the laser to the center of the circle. You must then click **inside** the circle to obtain a laser focus point.
   - After the laser focus is completed, the software displays the found Z location above the light level in the lower-left corner of the Image window.
8. Press **Enter** on the joystick to accept the Z value of the point in the feature measurement.

9. If you are measuring a feature that requires more than one laser focus point, e.g., a Plane, repeat Steps 5 through 8 for each laser focus point.
10. Click **OK** in the measurement step.

Note: The accuracy of the laser is independent of magnification level. The optics can be anywhere within the zoom range when using the laser.

How to Use Laser Scan

Follow the steps below to measure a feature using a Laser Scan strategy.

1. Click the **Laser** icon in the toolbox or select **Laser** in the **Tools** menu to activate the laser function.
2. In the Laser Settings window, select the desired laser scan strategy and point frequency (described on the next page).
3. If you want to change the advanced laser settings or view the sensor graph, click **Advanced** and make the desired changes (see page 3-9 for more information).
4. Select the desired Measure function to measure the feature, e.g., Circle.
5. Display the feature under the optics and make sure the image is in focus. If it is not, focus the image manually by rotating the Z axis fine adjustment knob on top of the joystick or use a Focus tool.
6. Specify the required number of points (for example, three points for a circle) for the selected scan strategy by clicking on them in the Image window. The feature does not have to be in the field of view; you can use the joystick to move the feature and/or adjust the focus.

   The software displays the following information at the bottom of the Image window:

   - The time it will take for the scan to be completed (T)
   - The number of points that the laser is expected to scan (P)
   - The number of points selected to initiate the scan

WARNING: To prevent hazardous radiation exposure to your eyes, do not look directly at the laser beam while operating the laser.

7. Click on the last point again (place the cursor exactly on the point) or click **Scan** to begin the laser scan. The system moves the laser to the optics location, turns off the video illumination and performs a scan to measure the feature.
   - If the Laser On check box is selected in the Advanced Laser Settings window, the software returns to the starting point of the laser.
   - If the Laser On check box is not selected in the Advanced Laser Settings window, the software returns to the starting point of the optics.
8. Compare the number of expected points with the actual number of points in the step. If the values differ by more than 10%, determine the reason for the difference, e.g., significant Z height variations, and evaluate whether the scan should be repeated with different parameters.

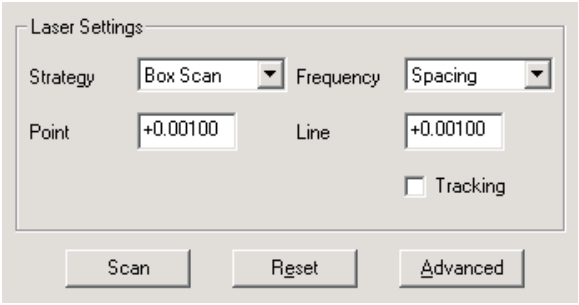
Note: The actual number of points in the step represents the number of valid data points obtained during the scan.

9. Click **OK** in the measurement step.

Note: The accuracy of the laser is independent of magnification level. The optics can be anywhere within the zoom range when using the laser.

Laser Settings Window

The software displays the following Laser Settings window next to the DRO window when you activate the laser function.



The Laser Settings window contains the following items:

- **Strategy** drop-down list, which indicates how the feature will be measured with the laser.
  - **Laser Focus**, which indicates that the laser will focus a point on a surface. Only the Reset and Advanced buttons are enabled when you select this strategy; the other settings are all disabled.
  - **Laser Scan** strategy, which indicates how the surface will be scanned.
- **Spacing/Density for Points and Lines**. This determines whether the concentration of points and lines scanned by the laser are displayed in terms of **Spacing** (distance between points) or **Density** (number of points per unit of distance).
- **Tracking** check box, which indicates whether or not the scan will track the position of the Z (described on page 3-8). When tracking is On, the system repositions the sensor to keep the object near the center of the capture range. For example, this may be useful when measuring a feature at different Z heights.
  - See the *Laser Tracking Sensitivity* topic to control how responsive the tracking will be to small changes in the surface of the part.
- Laser control buttons

Notes:

1. Each Laser Setting window item is explained in more detail on the following pages.
2. The Scan button is disabled (greyed out) under the following circumstances: the Focus strategy is selected, the required number of points for a scan have not been selected, or the expected number of points to be included in the scan exceeds 99,999.

Laser Scan Strategy

The laser scan strategy indicates how the surface will be scanned when you use the **Laser Scan** function. The number of points that you need to specify when you use a Laser Scan function depends on the selected scan strategy.

You can select one of the following scan strategy options from the drop-down box in the Laser Settings window:

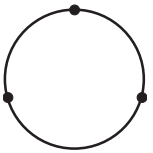
Linear

- **Linear:** used for features such as contours or lines. Requires 2 definition points.

Arc

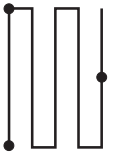
- **Arc:** used for rounded features such as corners. Requires 3 definition points.

Circular



- **Circular:** used for features such as planes. Requires 3 definition points.

Box



- **Box:** used for an area scan of a rectangular feature or surface mapping. Requires 3 definition points.
  - The first two points define the orientation (direction) and length.
  - The third point defines the width.

Point and Line Spacing

When you select a Laser Scan strategy and select **Spacing** from the drop-down box in the Laser Scan Settings window, you can specify the distance between each point (or line) in the current measurement units (inches or millimeters).

- The first field contains the spacing between each point. The value in this field indicates how many points will be taken in the scan.
- If a Box scan strategy is selected, the second field is enabled; it contains the spacing between each line of the box scan. This determines how many lines of data will be taken in the scan.

You can change the values in each field in the following ways:

- When you increase the spacing value, there is more space between each point (or line) and fewer points are used for the scan. If the entered value is too large (for example, larger than the distance from the start point to the end point), the system may return an invalid calculation.
- When you decrease the spacing value, there is less space between each point (or line) and more points are used for the scan.

Point and Line Density

When you select a Laser Scan strategy and select **Density** from the drop-down box in the Laser Scan Settings window, you can specify the number of points (or lines) per the current unit of distance.

- The first field contains the number of **points** per inch or millimeter. The value in this field indicates how many points will be taken in the scan.
- If a Box scan strategy is selected, the second field is enabled; it contains the number of scan **lines** per inch or millimeter.

You can change the values in each field in the following ways:

- When you increase the value, there is less space between each point (or line) and more points are used for the scan.
- When you decrease the value, there is more space between each point (or line) and fewer points are used for the scan.

Notes:

1. Spacing and Density are related; adjusting one automatically adjusts the other. For example, increasing the spacing value between each point automatically decreases the point density and vice-versa.
2. Set the spacing/density values based on the overall length of the scan and characteristics of the surface. For example, if the surface has low frequency changes, use a large spacing (low density) value and vice-versa.
3. If the expected number of points in a scan exceeds 99,999, you will need to change the spacing/density values to enable the Scan button in the Laser Settings window.

Tracking Check Box

When tracking is On, the system repositions the sensor Z location to keep the object near the center of the capture range. This feature is useful when measuring a feature that has surface height changes that are greater than the sensor capture range. If tracking is Off for such a part, features outside the capture range will be clipped.

Important: Pay attention to clearances between the part and fixture over the scan length. Even with Tracking turned on, there may be clearance issues you should consider.

Note: See *Laser Tracking Sensitivity* for information about controlling how responsive the tracking will be to small changes in the surface of the part.

Laser Control Buttons

The three buttons in the Laser Settings window provide you with the following laser controls:

- **Scan** button:
  - This button is enabled only after you specify the minimum number of points for the selected laser scan strategy and the expected number of points to be included in the scan does not exceed 99,999.
  - Click on this button to begin the laser scan. (You can also click on the last point again to initiate the scan.)
  - If you change any of the laser scan settings and/or advanced laser settings, click on this button to redo the laser scan and test your changes. The software incorporates the changes into the laser analysis and remeasures the feature.

- This button is disabled if Laser Focus is selected.

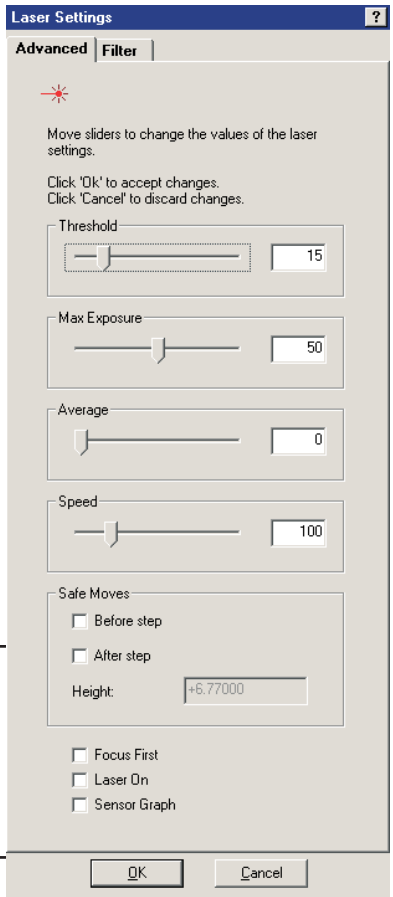
- **Reset** button. If you do not like the effects of your changes to the laser settings or advanced laser settings, click on this button to reset all the advanced laser settings to their defaults.
- **Advanced** button. Click on this button to display the advanced laser settings in the Measurement window (described next). This also displays the laser filters when you click the **Filter** tab (described later).

Advanced Laser Settings

The advanced laser settings are displayed in the Measurement window area when you click **Advanced** in the Laser Settings window.

You can control the use and importance of each laser setting (that is, "fine-tune" which settings are used in the laser analysis) in the following ways:

- **Threshold** slider. This controls the height of the threshold bar in the sensor graph. Signals below the threshold bar are eliminated from the evaluation and signals above the bar are included in the evaluation.
  - Move the slider right to raise the bar and eliminate the effects of unwanted signals, such as secondary reflections. The data below the bar, such as background and camera noise, is ignored. The data above the bar is included in the evaluation.
  - Move the slider left to lower the bar and include more data in the evaluation.



Tip: Use the laser sensor graph to set the threshold as low as possible for more accurate measurement results. However, settings too low can cause unreliable readings. See the illustration on page 3-14.

- **Max Exposure** slider. This parameter controls the maximum amount of time that the laser will expose the sensor at each point for a valid reading to be returned. This is a percentage from the shortest to longest exposure in 1-unit increments. This parameter has a significant impact on scan velocity and time. As you increase the exposure time, the scan velocity decreases, which in turn increases the time needed to complete the scan. Typically, the more diffuse the surface, the longer you should set the exposure.

Note: If you experience data drop-outs (data points missing) when you perform a scan, you may need to increase the Max Exposure parameter.

  - Valid values range from 0 to 100, and the default is 50.
  - Moving the slider left decreases the maximum exposure and increases the scan velocity.
  - Make sure that the exposure is high enough to get all the data points, especially with low reflectivity on a specular surface or low diffusion on a diffuse surface.
  - You can adjust this setting using the actual exposure at the top of the exposure graph.

- **Speed** slider. This controls the maximum speed of the stage motion during a laser scan.
  - The range is from 0 to 500%. The default is 100%.
  - The default speed is based on the following mathematical expression: MIN (maximum stage velocity, spacing/max. exposure time). For example, if the average exposure time is 50% of the maximum exposure, you can increase the maximum speed by 2X, i.e., move the slider to 200%, and potentially get the same number of points at the same spacing.
  - If the stage moves too fast during a laser scan and points are not captured properly, you can move the slider to a lower percentage to lower the speed. This reduces the distance over which the laser takes data for each point.
  - This parameter appears only if a laser scan strategy is selected.

Note: Typically, you should adjust the Max Exposure parameter before adjusting the Speed parameter.

- **Average** slider. This controls how many exposures will be performed and averaged to return a single point. Valid values range from 1 to 9999. This parameter is enabled only if the Laser Focus strategy is selected and it is used when the Focus First is checked for a laser scan.
- **Safe Moves** section. Allows you to specify a safe height when moving the DRS laser between steps (described on the following page).
- **Focus First** check box. Select this check box to automatically perform a laser focus at the starting point of the scan. This parameter is used to help put the scan start point within the laser capture range.
- **Laser On** check box. Select this check box to turn on the laser (described on page 3-13).
- **Sensor Graph** check box. Select this check box to display the diagnostic graph (described on page 3-14).

Safe Moves

The Safe Moves options in the Advanced Laser Settings window enables you to specify a safe height to which a laser can be moved when going from the current location to the next location. These options enable the laser to safely move around protruding objects instead of crashing into them.

You can select the following options:

- Select **Before Step** to move the laser to the specified height before any movement in X or Y at the beginning of a measurement. The default is unchecked.
- Select **After Step** to move the laser to the specified height before any movement in X or Y at the end of a measurement. The default is unchecked.
- Specify the **safe height** to which the laser can be moved. The default is the maximum Z travel when the machine is powered up; after you specify a Z zero location, it is the distance from the current Z zero location to the upper Z limit. After you specify a Z datum, it is the distance from the current part Z datum location to the upper Z limit.
  - The height is displayed in the current units.
  - A safe move can only go up; it will not move down.

If either the Before Step or After Step boxes are selected during the creation or step editing of a laser measurement step, the safe moves are done **both** at the beginning and end of the step.

1. The specified options carry forward to other steps that are measured with the laser. However, the height gets changed to the default whenever a step that changes the current Z zero location is created.
2. To restore the default settings, click **Reset** in the Laser Settings window.

Laser On Check Box

If you select the Laser On check box in the Advanced Laser Settings window, the system turns on the laser and uses the point under the laser rather than the point under the optics.

This also:

- Allows you to see the laser spot on the feature

WARNING: To prevent hazardous radiation exposure to your eyes, do not look directly at the laser beam.

- Blacks out the Image window and fills in the center of the Laser Focus tool
- Displays a bar on the left side of the Image window
  - The bar indicates the capture range.
  - The box inside the bar indicates where the object is within the capture range.
- Displays an exposure graph on the top of the Image window
  - The graph indicates the actual/maximum exposure timeout ratio.
  - The red bar inside the graph indicates the potential number of points that may be missed. The bar should consistently use about half of the graph. If the bar uses more than half of the graph, you may wish to increase the maximum exposure; however, this will slow down the laser scan.
- Displays the exposure time and the found Z location, if the parameter is turned on.
- Displays a prompt to move the laser to the current optical position.
  - Click **Yes** to move the laser to the current optical position.
  - Click **No** if you do not wish to move the laser to the current optical position.

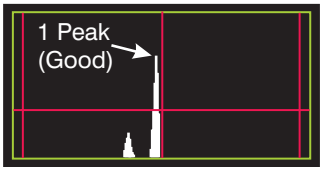
When you click in the laser circle to use the laser, the system moves to the last found Z position, centering the focus. When you press **Enter** on the joystick, the software places the point in the measurement step.

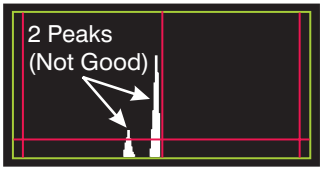
Note: When the laser is On, the sensor graph is updated at the same frequency as the points are measured.

Sensor Graph

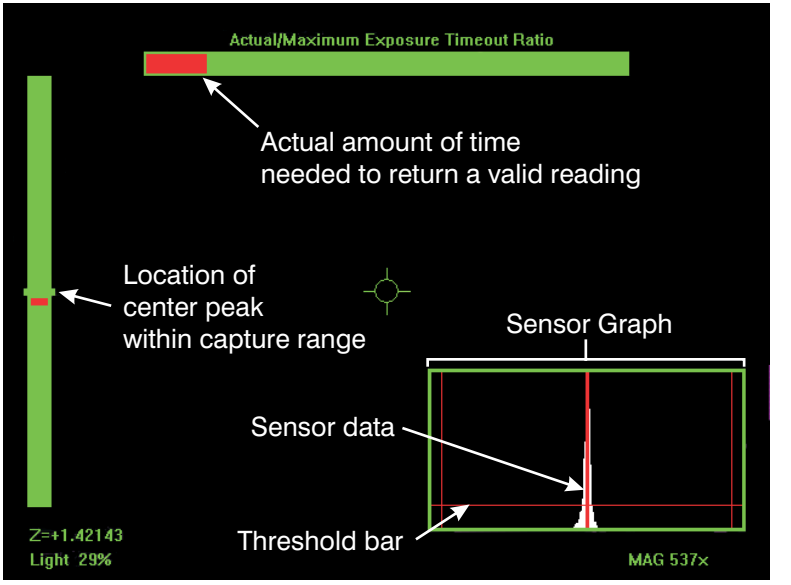
The sensor graph is displayed in the Image window when you select the **Sensor Graph** check box in the Advanced Laser Settings window.

- **Time graph** (top), which indicates the actual amount of time that is needed to return a valid reading.
- **Position graph** (left), which indicates the current position within the laser's capture range. If you are using the graph to position the laser, the best location is at the middle of the graph.
- **Sensor graph** (bottom).
  - Evaluated points are shown in a box in the Image window. The width of the box is a graphical representation of the laser ***sensor's range***. The height of the box indicates what the laser finds. A vertical line indicates the center of the laser ***capture range***; a horizontal line indicates the current threshold level, which is set in the Advanced Laser Parameters window.
  - The laser data are displayed in white and the graph is shown in the color of the current target.
  - Points in the middle (spikes) are typically the best points. Points below the threshold bar indicate reflections and noise. A point above the threshold bar displays the calculated Z axis position with the maximum contrast.

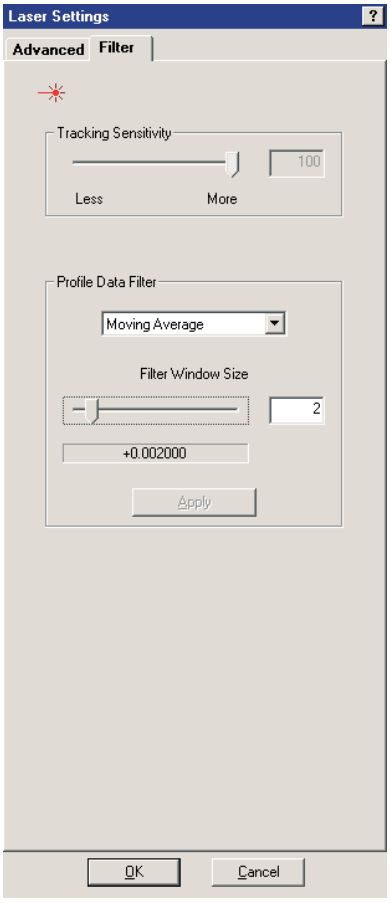




Tip: Use the Sensor graph to set the threshold as low as possible while avoiding multiple peaks across the threshold . This produces more accurate measurement results.



Laser Filters



The laser filters are used to attenuate the scene-dependent noise inherent to all laser scans; this effectively increases the accuracy of the laser sensor measurements.

To display the laser filters in the Measurement Window area, click **Advanced** in the Laser Settings window and then click the **Filter** tab. The filters can be accessed only if a laser scan strategy is selected.

You can apply filtering to laser scan point data in the following ways:

- **Eliminate Laser Scan Fliers** - enables an algorithm to filter laser scan data and remove fliers from the final calculation of a line and circle (or arc) feature.
- **Profile Data Filter** - This drop-down box enables you to select the profile data filter that is applied to the scanned data. For a box scan, the filters are applied on a line-by-line basis.
  - **None**. This means that no filtering is applied to the scanned data.
  - **Moving Average** (default). This filter calculates the arithmetic average of the raw Z data points within the specified moving window size. This filter is more suited to flat parts. For example, use this filter when you wish to smooth out the form for a flat surface.
  - **Best Fit**. This filter calculates each raw data Z and the points within the specified moving window size using a best-fit algorithm. This filter is more suited to non-flat parts. For example, use this filter when you wish to maintain the form while smoothing out the noise inherent to the data points.
  - Interpolation of the X, Y and Z values occurs for all profile data filter settings.

- **Filter Window Size** - This control defines the width of a window that is superimposed on a set of scanned data. The way in which the data is evaluated at each point within this window depends on the selected profile data filter.
  - The slider specifies a multiplier that is used to multiply the point spacing in the Laser Settings window to set the appropriate filter window size for the scan. The range of the multiplier is 0 to 25 times the current point spacing value. The default is 2. A value of zero turns off the filtering completely, which results only in interpolated points.
  - The text field below the slider displays the current window size, which is the result of the expression (Point Spacing x Multiplier), i.e., the value is a multiple of the current point spacing value of the scan.

Click **Apply** to dynamically apply the selected filter settings on the current scanned data. This enables you to try out different filter settings on the same raw data set.

- You can apply the filters only when a step is open and scanned data exists in memory, i.e., you have not yet clicked OK. If you are editing a step, you must re-scan the part first; otherwise the Apply button is grayed out.
- You cannot dynamically re-apply profile data filtering to existing area scan data. You must set the desired filter settings before doing the area scan; the filters are applied only during the area scan.

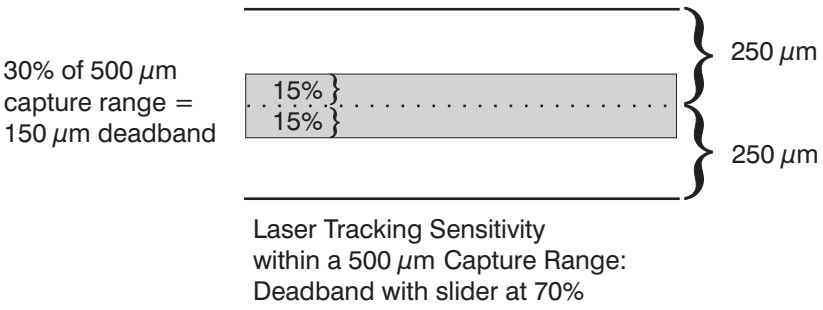
Note: See the *Laser Tracking Sensitivity* topic (described next) to control how responsive the tracking will be to small changes in the surface of the part.

Laser Tracking Sensitivity

The **Tracking Sensitivity** slider in the Laser Filters window defines a "deadband" area (zone) within which the laser does not track. This controls how responsive the laser tracking capability will be to small changes in the surface of the part.

- The range is from 0 to 100%. The default is 100%.
- Move the slider right to increase the sensitivity. This decreases the deadband, allowing tracking to occur for small surface variations.
- Move the slider left to decrease the sensitivity. This increases the deadband, allowing for a mechanically smooth scan on a rough surface.
- This slider works only when **Tracking** is enabled in the Laser Settings window.

Note: Tracking sensitivity does not affect measurement results if the surface roughness is within the working range of the laser.



Laser Tracking Sensitivity
within a 500 µm Capture Range:
Deadband with slider at 70%

Laser Scan Flier Elimination

The **Eliminate Fliers** check box in the Advanced Laser Filter window enables an algorithm to filter laser scan data and remove fliers from the final calculation of a line and circle (or arc) feature. The filter removes errors caused by things such as dust particles and the imaging of edges with the laser. For example, in order to fully measure a part, the laser scan may run off the end of the material, resulting in data being collected that was not a part of the desired surface.

Note: A flier is an anomalous data point taken by the laser that is caused, for example, by surface contamination or scanning off the edge of a part.

To use the laser scan filter:

- Select the **Eliminate Fliers** check box to enable the filter. This causes any subsequent laser scans to be filtered using the value specified in the tolerance band edit field.
  - A Line or Circle step must be open when you select the check box.
  - You cannot enable this filter if a step is not being measured or if the feature is not a line or a circle.
- Specify a **Tolerance Band** value in the edit field. The software uses the value to filter the points that were collected during the laser scan.
  - This value represents the total width of the window. For example a value of 1.0 mm would remove points that lie outside of a 0.5 mm band.
  - If the value is 0.0, the software calculates the default tolerance band after the scan is completed and puts it in the edit field. It also calculates the standard deviation of the scanned data relative to the best-fit feature, defines the tolerance band to be +/- 3 standard deviations, and displays the default tolerance band on the screen.

When you use the laser scan filter, the software:

- Calculates the best-fit feature from the scanned data.
- Eliminates any points that lie outside the defined tolerance band.
- Recalculates the best-fit feature from the points within the defined tolerance band.

Notes:

1. If you want to have the software recalculate a default tolerance band after a measurement has been done, specify a 0.0 value in the Tolerance Band edit box and click **Apply** in the Advanced Laser Settings window.
2. If you change the check box or edit value after a scan, the software will not filter the data unless you click **Remeasure** or **Apply**.
3. See the Measure-X on-line Help topic *Laser Scan Flier Elimination Example* for an example of how a sample data set would be filtered using the laser scan flier elimination algorithm.

Using the Laser Target in MeasureMind 3D

This subsection describes how to use the Laser target in MeasureMind 3D.

Note: See *Using the Laser Tool in Measure-X* for information about using the DRS laser on systems equipped with Measure-X.

Laser Functions

The following laser functions are available on systems equipped with a laser sensor and the MeasureMind 3D software:

- Use **Laser Focus** to focus a point on the surface of a part, e.g., to measure the Z axis position. The software "looks" at image data from several Z axis positions and calculates the Z axis position that yields the best laser focus, or highest contrast.
- Use a **Laser Scan** strategy to scan the surface of a part between specified points and produce a high resolution surface profile.

To activate the laser functions, click the appropriate laser icon in the toolbox or select **Laser** ⇒ **Focus** or **Laser** ⇒ **Scan** in the **Targets** menu.

Note: The accuracy of the laser is independent of magnification level. The optics can be anywhere within the zoom range when using the laser.

How to Use Laser Focus

To measure a feature with the Laser Focus target, follow the steps below.

1. Click the **Laser Focus** icon or select **Laser** ⇒ **Focus** in the **Targets** menu.
   - The software displays the laser focus target, which appears in the center of the Image window, as a circle target with crosshairs.
   - The Laser Settings window appears at the bottom of the screen (described on page 3-22).

2. Select the desired Measure function to measure the feature, e.g., Plane.
3. Locate the feature under the optics and make sure the image is optically focused. If it is not, focus the image manually by rotating the Z axis fine adjustment knob on top of the joystick or use a Focus target.

4. Make any desired changes in the Laser Settings window (see page 3-22 for more information)
5. If you want to change the advanced laser parameters, click **Advanced** and make the desired changes (see page 3-31 for more information).
6. Click on the feature to be measured (outside the laser target) to bring it inside the laser target.

WARNING: To prevent hazardous radiation exposure to your eyes, do not look directly at the laser beam while operating the laser.

7. Click **inside** the Laser Focus target to perform the laser focus. The system moves the laser to the optics location, turns off the video illumination, performs the laser focus (which is indicated by a flash of the blue Laser Indicator LED), and obtains a focus point.
   - If it is not successful on the first attempt, it will continue trying in increments of 90% of the capture range for the number of attempts specified in the LASER.CFG file. In this case, it moves the stage in the second attempt, depending on the configuration settings.
   - If it fails, twist the joystick knob until the focus is within range and click inside the laser target to perform the focus manually. If you wish, you can also use the sensor graph (described on page 3-25).
8. Press **Enter** on the joystick to accept the Z value of the point in the feature measurement.
9. If you are measuring a feature that requires more than one laser focus point, e.g., a Plane, repeat Steps 3 through 8 for each laser focus point.
10. Click **Done** in the measurement step.

Notes:

1. The accuracy of the laser is independent of magnification level. The optics can be anywhere within the zoom range when using the laser.
2. When you run or step edit the routine, the software automatically turns off the video illumination for the focus. The illumination is turned back on when the next optical step is measured.

How to Use Laser Scan

To measure a feature using the Laser Scan target, follow the steps below.

1. Click the **Laser Scan** icon or select **Laser** ⇒ **Scan** in the **Targets** menu to activate the laser function.
   - The Laser Settings window appears at the bottom of the screen (described on the next page).
2. In the Laser Settings window, select the desired laser scan strategy and laser point and line spacing.
3. If you want to change the advanced laser parameters, click **Advanced** and make the desired changes (see page 3-31 for more information).
4. Select the desired Measure function to measure the feature, e.g., Circle.
5. Display the feature under the optics and make sure the image is optically focused. If it is not, focus the image manually by rotating the Z axis fine adjustment knob on top of the joystick or use a Focus target.
6. Specify the required number of points for the selected scan strategy by clicking on them in the Image window. The feature does not have to be in the field of view; you can use the joystick to move the feature and/or adjust the focus.

WARNING: To prevent hazardous radiation exposure to your eyes, do not look directly at the laser beam while operating the laser.

7. Click on the last point again (place the cursor exactly on the point) or click **Scan** to begin the laser scan. The system moves the laser to the optics location, turns off the video illumination, and performs a scan to measure the feature.
   - If the Laser On check box is selected in the Laser Settings window, the software returns to the starting point of the laser.
   - If the Laser On check box is not selected in the Laser Settings window, the software returns to the starting point of the optics.

Note: The direction of the laser scan is determined by the order (direction) in which the points were specified (i.e., left to right).

8. Compare the number of expected points with the actual number of points in the step. If the values differ by more than 10%, determine the reason for the difference, e.g., significant Z height variations, and evaluate whether the scan should be repeated with different parameters.

Note: The actual number of points in the step represents the number of valid data points obtained during the scan.

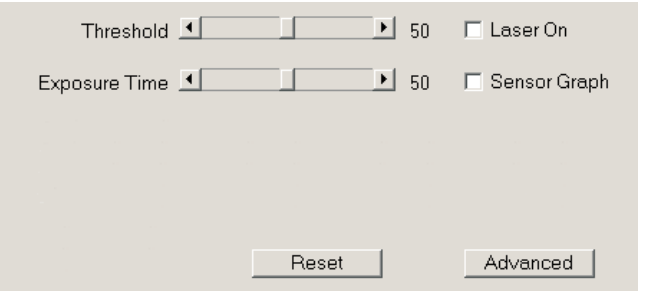
9. Click **Done** in the measurement step.

Notes:

1. The accuracy of the laser is independent of magnification level. The optics can be anywhere within the zoom range when using the laser.
2. When you run or step edit the routine, the software automatically turns off the lights for the scan. The lights are turned back on when the next optical step is measured.

Laser Settings Window

You can control the use and importance of each laser setting (that is, "fine-tune" which settings are used in the laser analysis) in the Laser Settings window.



This window displays the following settings for the Laser Focus and Laser Scan targets:

- **Threshold** slider to control the height of the threshold bar in the sensor graph
- **Exposure Time** slider to control the amount of time that the sensor array collects data per point
- **Laser On** check box to turn the laser on
- **Sensor Graph** check box to display the diagnostic graph
- **Reset** button. If you do not like the effects of your changes to the laser settings or advanced laser settings, click this button to reset all the advanced laser settings to their defaults.
- **Advanced** button. Click this button to display the Advanced Laser Settings.

This window displays additional laser scan settings if you are using the Laser Scan target, as shown on page 3-26. Each Laser Settings window item is explained in more detail on the following pages.

Laser Threshold

The laser **Threshold** slider in the Laser Settings window controls the height of the threshold bar in the sensor graph. Data below the bar is eliminated from the evaluation. Data above the bar is included in the evaluation.

- Move the slider right to raise the bar and eliminate the effects of unwanted signals, such as secondary reflections. The data below the bar, such as background and camera noise, is ignored. The data above the bar is included in the evaluation.
- Move the slider left to lower the bar and include more data in the evaluation.

Tip: Use the sensor graph to set the threshold as low as possible without including secondary spots (multiple peaks) above the threshold. This produces more accurate measurement results. However, settings that are too low can cause unreliable results.

Laser Exposure Time

The laser **Exposure Time** slider in the Laser Settings window controls the amount of time that the sensor array collects data per point. This is a percentage from the shortest to longest exposure in 1-unit increments.

- Moving the slider left decreases the maximum exposure and increases the scan velocity.
- Make sure that the exposure is high enough to get all the data points, especially with low reflectivity on a specular surface or low diffusion on a diffuse surface.
- You can adjust this setting using the following ratio: 100%/actual exposure in the exposure graph.

Laser On Check Box

If you select the **Laser On** check box in the Laser Settings window, the system turns the laser On and uses the point under the laser rather than the point under the optics.

This also:

- Allows you to see the laser spot on the feature.

WARNING: To prevent hazardous radiation exposure to your eyes, do not look directly at the laser beam.

- Sets the laser for auto-measurement
- Blacks out the Image window and fills in the center of the Laser Focus target
- Displays a bar on the left side
  - The bar indicates the capture range
  - The box inside the bar indicates where the object is within the capture range
- Displays an exposure graph on the top
  - The graph indicates the actual/maximum exposure timeout ratio.
  - The red bar inside the graph indicates the potential number of points that may be missed. The bar should consistently use about half of the graph. If the bar uses more than half of the graph, you may want to increase the maximum exposure; however, this will slow down the laser scan.
- Displays a prompt to move the laser to the current optical position
  - Click **Yes** to move the laser to the current optical position.
  - Click **No** if you do not want to move the laser to the current optical position.

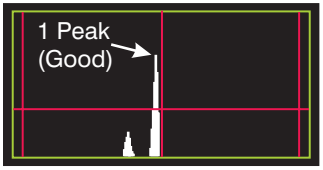
When you click in the laser circle to use the laser, the system moves to the last found Z position, centering the focus. When you press **Enter** on the joystick, the software places the point in the measurement step.

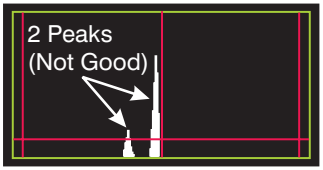
When the laser is On, the sensor graph is updated at the same frequency as the points are measured.

Sensor Graph

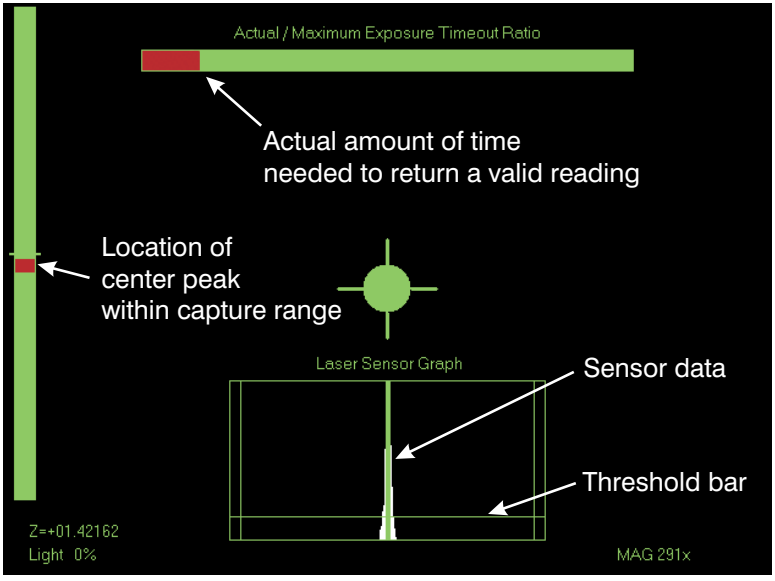
The laser sensor graph is displayed when you select the **Sensor Graph** check box in the Laser Settings window. The graph window displays three graphs:

- **Time graph** (top), which indicates the actual amount of time that is needed to return a valid reading.
- **Position graph** (left), which indicates the current *position* within the laser's capture range. If you are using the graph to position the laser, the best location is at the middle of the graph.
- **Sensor graph** (bottom).
  - Evaluated points are shown in a box in the Image window. The width of the box is a graphical representation of the laser ***sensor's range***. The height of the box indicates what the laser finds. A vertical line indicates the center of the laser ***capture range***; a horizontal line indicates the current threshold level, which is set in the Advanced Laser Parameters window.
  - The laser data are displayed in white and the graph is shown in the color of the current target.
  - Points in the middle (spikes) are typically the best points. Points below the threshold bar indicate reflections and noise. A point above the threshold bar displays the calculated Z axis position with the maximum contrast.



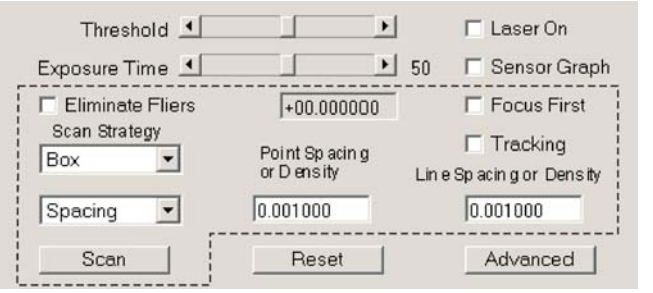


Tip: Use the Sensor graph to set the threshold as low as possible while avoiding multiple peaks. This produces more accurate measurement results.



Laser Scan Settings

The software displays the following *scan-specific* settings (enclosed by a dashed line) in the Laser Settings window if you are using the Laser Scan target (see the *Laser Settings Window* topic for the other settings that apply to both the Laser Focus and Laser Scan targets).



- **Eliminate Fliers** check box and window size field. This enables an algorithm to filter laser scan data and remove fliers from the final calculation of a line and circle (or arc) feature.
- **Scan strategy**, which indicates how the surface will be scanned during the laser operation.
- **Spacing/Density for Points and Lines.** This determines whether the concentration of points and lines scanned by the laser are displayed in terms of Spacing (distance between points) or Density (number of points per unit of distance).
- **Tracking** check box, which indicates whether the scan will track Z or not.
- **Focus First** check box to turn on autofocus at the starting point of the scan.
- Laser **Scan** button. Click this button to begin the laser scan after you specify the minimum number of points for the selected laser scan strategy. You can also click on the last point again to initiate the scan.
    - If you change any of the laser scan settings and/or Advanced Laser settings, click on the Scan button to redo the laser scan and test your changes. The software incorporates the changes into the laser analysis and re-measures the feature.

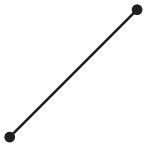
Note: Each laser scan setting is explained in more detail on the following pages.

Scan Strategy

The laser scan strategy indicates how the surface will be scanned when you use the **Laser Scan** target. The number of points that you need to specify when you use a Laser Scan function depends on the selected scan strategy.

In the Laser Settings window, you can select one of the following scan strategy options from the drop-down box:

Linear

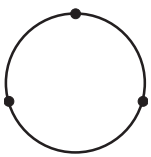


- **Linear:** used for features such as contours or lines. Requires 2 definition points.

Arc

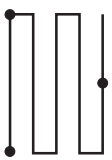
- **Arc:** used for rounded features such as corners. Requires 3 definition points.

Circular



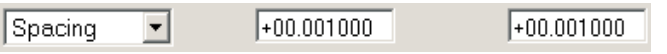
- **Circular:** used for features such as planes. Requires 3 definition points.

Box



- **Box:** used for an area scan of a rectangular feature or surface mapping. Requires 3 definition points.
  - The first two points define the orientation (direction) and length.
  - The third point defines the width.

Point and Line Spacing



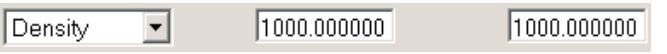
When you use the Laser Scan target and select **Spacing** from the drop-down box in the Laser Scan Settings window, you can specify the distance between each point (or line) in the current measurement units (inches or millimeters).

- The first field contains the spacing between each **point**. The value in this field indicates how many points will be taken in the scan.
- If a Box scan strategy is selected, the second field is enabled; it contains the spacing between each **line** of the box scan. This determines how many lines of data will be taken in the scan.

You can change the values in each field in the following ways:

- When you increase the spacing value, there is more space between each point (or line) and fewer points are used for the scan. If the entered value is too large (for example, larger than the distance from the start point to the end point), the system may return an invalid calculation.
- When you decrease the spacing value, there is less space between each point (or line) and more points are used for the scan.

Point and Line Density



When you use the Laser Scan target and select **Density** from the drop-down box in the Laser Scan Settings window, you can specify the number of points (or lines) per the current unit of distance.

- The first field contains the number of **points** per inch or millimeter. The value in this field indicates how many points will be taken in the scan.
- If a Box scan strategy is selected, the second field is enabled; it contains the number of scan **lines** per inch or millimeter.

You can change the values in each field in the following ways:

- When you increase the value, there is less space between each point (or line) and more points are used for the scan.
- When you decrease the value, there is more space between each point (or line) and fewer points are used for the scan.

Notes:

1. Spacing and Density are related; adjusting one automatically adjusts the other. For example, increasing the spacing value between each point automatically decreases the point density and vice-versa.
2. Set the spacing/density values based on the overall length of the scan and characteristics of the surface. For example, if the surface has low frequency changes, use a large spacing (low density) value and vice-versa.
3. If the expected number of points in a scan exceeds 99,999, you will need to change the spacing/density values to enable the Scan button in the Laser Settings window.

Tracking Check Box

When tracking is On, the system repositions the sensor Z location to keep the object near the center of the capture range. This feature is useful when measuring a feature that has surface height changes that are greater than the sensor capture range. If tracking is Off for such a part, features outside the capture range will be excluded from the scan.

Important: Pay attention to clearances between the part and fixture over the scan length. Even with Tracking turned on, there may be clearance issues you should consider.

Note: See *Laser Tracking Sensitivity* for information about controlling how responsive the tracking will be to small changes in the surface of the part.

Laser Scan Button

The Scan button in the Laser Settings window is enabled only when you use a Laser Scan target and after you specify the minimum number of points for the selected laser scan strategy.

- Click **Scan** to begin the laser scan. You can also click on the last point again to initiate the scan.
- If you change any of the laser scan settings and/or advanced laser settings, click on the Scan button to redo the laser scan and test your changes. The software incorporates the changes into the laser analysis and remeasures the feature.
- The Scan button is disabled if Laser Focus target is selected.

Laser Scan Flier Elimination

The **Eliminate Fliers** check box in the Laser Scan Settings window enables an algorithm to filter laser scan data and remove fliers from the final calculation of a line and circle (or arc) feature. The filter removes errors caused by things such as dust particles and the imaging of edges with the laser. For example, in order to fully measure a part, the laser scan may run off the end of the material, resulting in data being collected that was not a part of the desired surface.

Note: A flier is an anomalous data point taken by the laser that is caused, for example, by surface contamination or scanning off the edge of a part.

To use the laser scan filter:

- Select the **Eliminate Fliers** check box to enable the filter. This causes any subsequent laser scans to be filtered using the value specified in the tolerance band edit field.
  - A Line or Circle step must be open when you click in the check box.
  - You cannot enable this filter if a step is not being measured or if the feature is not a line or a circle.
- Specify a **Tolerance Band** value in the edit field. The software uses the value to filter the points that were collected during the laser scan.
  - This value represents the total width of the window. For example a value of 1.0 mm would remove points that lie outside of a 0.5 mm band.
  - If the value is 0.0, the software calculates the default tolerance band after the scan is completed and puts it in the edit field. It also calculates the standard deviation of the scanned data relative to the best-fit feature, defines the tolerance band to be +/- 3 standard deviations, and displays the default tolerance band on the screen.

When you use the laser scan filter, the software:

- Calculates the best-fit feature from the scanned data.
- Eliminates any points that lie outside the defined tolerance band.
- Recalculates the best-fit feature from the points within the defined tolerance band.

Notes:

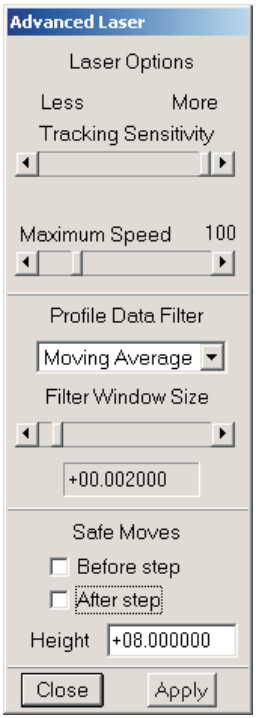
1. If you want to have the software recalculate a default tolerance band after a measurement has been done, specify a 0.0 value in the Tolerance Band edit box and click **Apply** in the Advanced Laser Settings window.
2. If you change the check box or edit value after a scan, the software will not filter the data unless you click **Remeasure** or **Apply**.

3. See the MeasureMind 3D on-line Help topic *Laser Scan Flier Elimination Example* for an example of how a sample data set would be filtered using the laser scan flier elimination algorithm.

Advanced Laser Settings

The advanced laser settings are displayed over the toolbox when you click **Advanced** in the Laser Settings window.

You can control the use and importance of each laser setting (that is, "fine-tune" which settings are used in the laser analysis) in the following ways:



- **Averages** - This controls how many exposures will be performed and averaged to return a single point. Valid values range from 1 to 9999. This parameter (not shown in the illustration) appears only if the Laser Focus target is selected.
- **Maximum Speed** - This controls the maximum speed of the stage motion during a laser scan.
  - The range is from 0 to 500%. The default is 100%.
  - The default speed is based on the following mathematical expression: MIN (maximum stage velocity, spacing/max. exposure time). For example, if the average exposure time is 50% of the maximum exposure, you can increase the maximum speed by 2X, i.e., move the slider to 200%, and still get the same number of points at the same spacing.
  - If the stage moves too fast during a laser scan and points are not captured properly, you can move the slider to a lower percentage to lower the speed. This reduces the distance over which the laser takes data for each point.
- **Tracking Sensitivity** - This defines a "deadband" within which the laser does not track (see the next page for more information).
- **Laser Filters** - These filters are used to attenuate the scene-dependent noise inherent to all laser scans (see page 3-32 for more information).
- **Safe Moves** - This enables you to specify a safe height when moving the laser between steps (see page 3-34 for more information).

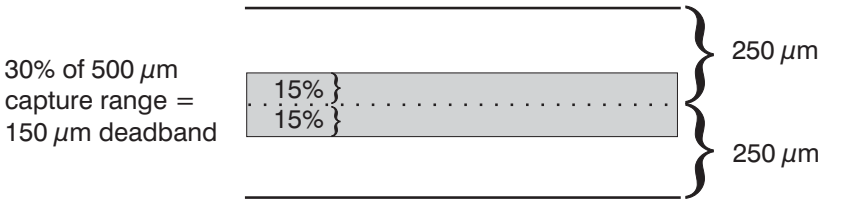
Laser Tracking Sensitivity

The **Tracking Sensitivity** slider in the Advanced Laser Settings window defines a "deadband" within which the laser does not track. This controls how responsive the laser tracking capability will be to small changes in the surface of the part.

- The range is from 0 to 100%. The default is 100%.
- Move the slider right to increase the sensitivity. This decreases the deadband, allowing tracking to occur for small surface variations.
- Move the slider left to decrease the sensitivity. This increases the deadband, allowing for a mechanically smooth scan on a rough surface.
- This slider works only when **Tracking** is enabled in the Laser Control window.

The illustration below shows a deadband of 30% when the slider is set at 70%. The laser does not track while operating within the deadband.

Note: Tracking sensitivity does not affect measurement results if the surface roughness is within the working range of the laser.



Laser Tracking Sensitivity
within a 500 μm Capture Range:
Deadband with slider at 70%

Laser Filters

The laser filters are used to attenuate the scene-dependent noise inherent to all laser scans; this effectively increases the accuracy of the laser sensor measurements.

To display the laser filters, click **Advanced** in the Laser Settings window, this displays the Advanced Laser Settings window. The filters can be accessed only if the laser scan target is selected.

You can apply filtering to laser scan point data in the following ways:

- **Profile Data Filter** - This drop-down box enables you to select the profile data filter that is applied to the scanned data. For a box scan, the filters are applied on a line-by-line basis.
  - **None.** This means that no filtering is applied to the scanned data.
  - **Moving Average** (default). This filter calculates the arithmetic average of the raw Z data points within the specified moving window size. This filter is more suited to flat parts. For example, use this filter when you wish to smooth out the form for a flat surface.
  - **Best Fit.** This filter calculates each raw data Z and the points within the specified moving window size using a best-fit algorithm. This filter is more suited to non-flat parts. For example, use this filter when you wish to maintain the form while smoothing out the noise inherent to the data points.
  - Interpolation of the X, Y and Z values occurs for all profile data filter settings.
- **Filter Window Size** - This control defines the width of a window that is superimposed on a set of scanned data. The way in which the data is evaluated at each point within this window depends on the selected profile data filter.
  - The slider specifies a multiplier that is used to multiply the point spacing in the Laser Settings window to set the appropriate filter window size for the scan. The range of the multiplier is 0 to 25 times the current point spacing value. The default is 2. A value of zero turns off the filtering completely, which results only in interpolated points.
  - The text field below the slider displays the current window size, which is the result of the expression (Point Spacing x Multiplier), i.e., the value is a multiple of the current point spacing value of the scan.

Click **Apply** to dynamically apply the selected filter settings on the current scanned data. This enables you to try out different filter settings on the same raw data set.

- You can apply the filters only when a step is open and scanned data exists in memory, i.e., you have not yet clicked the Done button. If you are editing a step, you must re-scan the part first; otherwise the Apply button is grayed out.
- You cannot dynamically re-apply profile data filtering to existing area scan data. You must set the desired filter settings before doing the area scan; the filters are applied only during the area scan.

Note: See the *Laser Tracking Sensitivity* topic (described next) to control how responsive the tracking will be to small changes in the surface of the part.

Laser Safe Moves

The safe moves options in the Advanced Laser Settings window enable you to specify a safe height to which the laser can be moved when going from the current location to the next location. These options enable the laser to safely move around protruding objects instead of crashing into them.

You can select the following options:

- Select **Before Step** to move the laser to the specified height before any movement in X or Y at the beginning of a measurement. The default is unselected.
- Select **After Step** to move the laser to the specified height before any movement in X or Y at the end of a measurement. The default is unselected.
- Specify the safe **Height** to which the laser can be moved. The default is the maximum Z travel when the machine is powered up; after you specify a Z zero location, it is the distance from the current Z zero location to the upper Z limit. After you specify a Z datum, it is the distance from the current part Z datum location to the upper Z limit.
  - The height is displayed in the current units.
  - A safe move can only go up; it will not move down.

If either the Before Step or After Step boxes are checked during the creation or step editing of a laser measurement step, the safe moves are done **both** at the beginning and end of the step.

Notes:

1. The specified options carry forward to other steps that are measured with the laser. However, the height gets changed to the default whenever a step that changes the current Z zero location is created.
2. To restore the default settings, click Reset in the Laser Settings window.

Retractable Laser

This subsection only applies to systems equipped with a retractable laser slide assembly. The software on these systems will retract and deploy the laser as needed. When you select the Laser Focus target or the Laser Scan target, or perform the laser alignment, the software displays a prompt to deploy the laser, if it is not already deployed.

- If you click **Yes**, the software automatically raises the optics along the Z axis and deploys the laser. Then you need to lower the laser to do the measurement with the selected target.
- If you click **No**, the software does not deploy the laser. In this case you need to deploy the laser manually.

To deploy the laser manually, you can either:

- In the **System** menu, select **Change Sensor** ⇒ **Deploy Laser**. The software raises the optics along the Z axis and deploys the laser.
- Raise the optics along the Z axis by twisting the joystick until you hear the first click, which picks up the laser (if you hear a second click, you have gone too far.)

When you are done using the laser, it is recommended that you retract the laser to avoid potential clearance problems when using video and/or touch probe.

To retract the laser manually, you can either:

- In the System menu, select **Change Sensor** ⇒ **Retract Laser**. The software raises the optics to the Z axis limit and retracts the laser.
- Raise the optics to the top of the Z axis travel; this retracts the laser.

Notes:

1. When you run a routine with laser steps, the software deploys and retracts the laser automatically, when needed.
2. For more information related to retractable lasers, see Appendix C.

Laser Slide Assembly

This subsection only applies to systems equipped with an adjustable (not retractable) laser slide assembly (i.e., SmartScope ZIP 250.) The laser on these systems is mounted to a slide which can be raised or lowered using the adjustment knob (see Figure 3-1). Twist the knob clockwise to raise the sensor, and twist it counterclockwise to lower the sensor. Tighten the set screw shown in Figure 3-1 to lock the laser slide in position.

Note: When the set screw is tightened, you cannot use the adjustment knob to raise or lower the slide.

Typically, the laser slide should be adjusted so that the laser and optics have approximately the same focal plane. However, the adjustable laser slide allows you to raise or lower the laser to accommodate the requirements for specific applications. The adjustment knob should not be used to focus the laser.

Important: Whenever you change the position of the adjustment knob, you need to perform the laser alignment procedures described in Section 2.

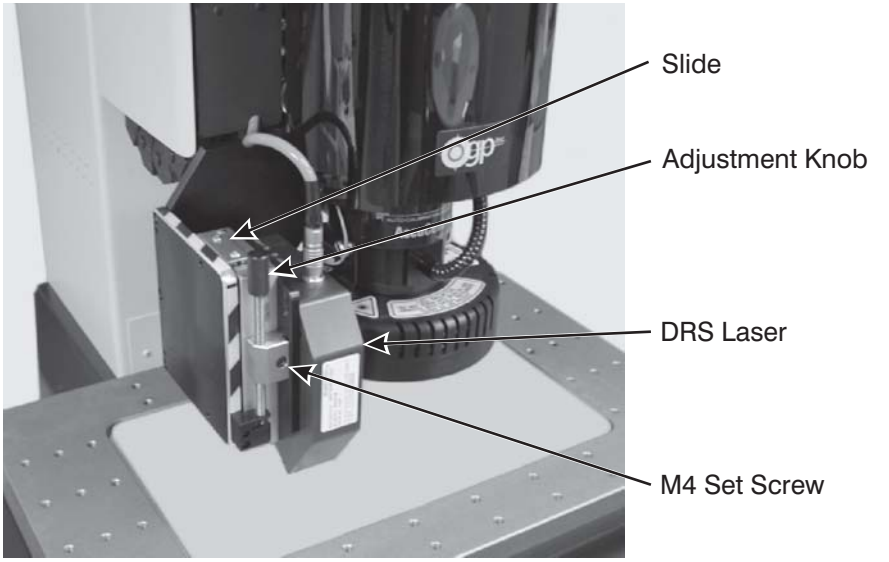


Figure 3-1. Adjustable Laser Slide Assembly and Adjustment Knob

Section 4

Viewing Surfaces

This section describes how to display a topographical view of the measured surface.

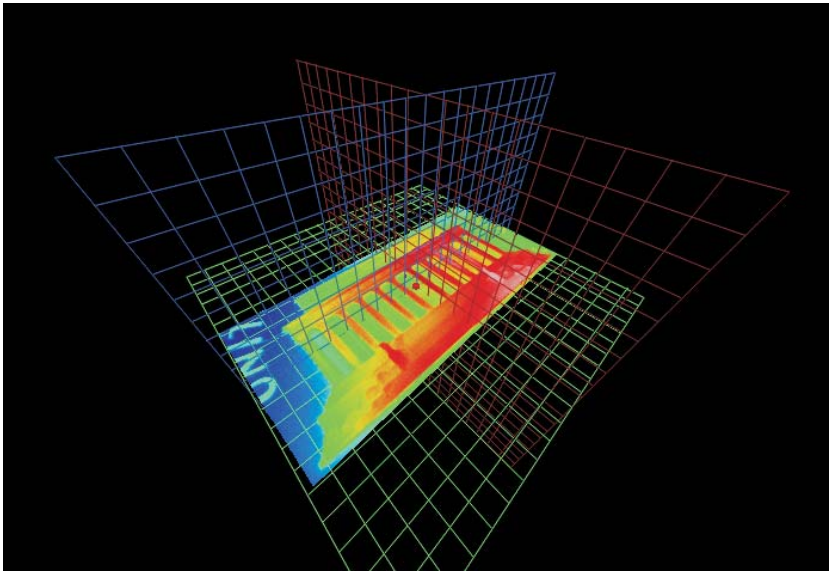
Surface Window

After performing a laser box scan, you can display a topographical view of the measured surface in the Surface window.

To display the Surface window, click the **Surface** icon in the Model window toolbar or:

- For Measure-X systems, select **Model** ⇒ **Surface View** in the **View** menu
- For MeasureMind 3D systems, select **Surface** ⇒ **Surface View** in the **View** menu

After measuring the feature, you must select it in the Model window before it can be displayed in the Surface window.



Surface Window Toolbar

The Surface window toolbar is displayed above the Surface window in the Measure-X software and below the Surface window in the MeasureMind 3D software. This window contains icons to help you manipulate the surface in the window. If you do not know the function of the icon, place the cursor over the icon. The system displays a tooltip for the icon.

This table lists the function of each icon in the Surface window toolbar.

Icon	Click on this icon to...
	**Only appears in the Measure-X software.** Save the image in an image file. See *How to Save the Model* in Section 2 of the Measure-X Reference Guide for more information.
	**Only appears in the Measure-X software.** Print the image. See *How to Print the Model* in Section 2 of the Measure-X Reference Guide for more information.
	Zoom all (fit to window)
	Zoom in
	Zoom out
	Display the isometric view of the surface
	Display the top view of the surface (default)
	Display the next view of the surface

Icon	Click on this icon to ...
	Close the Surface window and display the Model window
	View the solid surface
	View the wireframe of the surface
	View the individual surface points
	Turn the Auto Spin On/Off. This controls the continuos “spin” of the surface.
	Turn the Grid Axes On/Off. This is useful in viewing the orientation as the surface is rotated.
	**Only appears in the Measure-X software.** Display and change the colors of the Surface window attributes.
	**Only appears in the MeasureMind 3D software.** Turn the legend of the selected color map On/Off

Tip: When looking at the surface in Wireframe or Point mode, turn the Grid off to view the surface more easily.

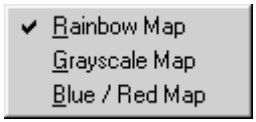
Colors of Surface Window Attributes

The Surface window has a black background. This enables the other colors to be displayed more vividly. However, if you print the surface (see *How to Print the Model* in the Measure-X Reference Guide or *Print the Screen or Video Image* in the MeasureMind 3D MultiSensor Reference Guide), the system reverses the black and white colors to save printer ink.

You can select different color maps for displaying the surface of the measured feature:

- Rainbow Map(default)
- Grayscale Map
- Blue / Red Map

To select a color map in the Measure-X software, you can either:



- Select the desired color map in the **View / Model** ⇒ **Surface View** ⇒ **Color Map** submenu.
- Click on the **arrow** next to the color map icon in the Surface window toolbar. This displays a drop-down list with color map icons. Then click on an **icon** to select the desired color map for the surface.

Note: If you want to display a legend of the selected color map in the Surface window (Measure-X software), click on the color map icon again.

To select a color map in the MeasureMind 3D software, select the desired color map in the **View / Surface** ⇒ **Color Map** submenu.

Note: If you want to display a legend of the selected color map in the Surface window (MeasureMind 3D software), click the **Legend On/Off** icon in the Surface window toolbar or select **Surface** ⇒ **Legend** in the **View** menu.

The color map legend contains a range of colors, which are used to produce a smooth gradient from the lowest points to the highest points on the surface. For example, the legend for the Rainbow color map contains the following range of colors:

- White: highest points
- Red
- Yellow
- Green
- Blue-green
- Dark Blue: lowest points

When the grid is turned on, its colors are the same as the coordinate system axes:

- XZ Plane: Red
- XY Plane: Green
- YZ Plane: Yellow

Mouse Functions in the Surface Window

This table defines the functions of a 3-button mouse in the Surface window.

Button	Function
Left	• Hold the button down and drag the mouse up to zoom the entire surface up. • Hold the button down and drag the mouse down to zoom the entire surface down. • Hold the button down and drag the mouse left for a Counter-Clockwise motion (roll). • Hold the button down and drag the mouse right for a Clockwise motion (roll).
Middle or **Wheel**	• Hold the button down and drag the mouse up to zoom the entire surface up. • Hold the button down and drag the mouse down to zoom the entire surface down.
Right	• Rotate the entire surface around the view origin by holding the button down and moving the cursor: – Left or right to rotate the surface left or right (yaw) – Up or down to rotate the surface up or down (pitch)

Section 5

Extracting Features

This section describes the Data Extraction function in the Measure-X software and explains how to extract features.

Data Extraction

The Data Extraction function enables you to construct a feature (Line, Circle, Plane, Sphere, Contour, Cone, Cylinder) from a subset of points taken from one or more measured reference features or composite features.

You can select one or more subsets in a reference feature in the Model window. You can select subsets from one feature or multiple features. Each subset is considered a “feature” and increments the Features counter in the constructed step.

Typically data is extracted from features that have many points. For example, it is common to construct lines and circles from contours that were measured with Edge Trace or a laser scan strategy.

If you copy an extracted feature, you may also need to copy the reference feature; otherwise the copy may cause an error to occur.

How to Extract Data

To extract data from one or more reference features, follow the steps below. It is assumed that you have measured a feature that has many points, e.g., Contour.

Note: To perform a Control-Click, press and hold the [Ctrl] key on the keyboard, click the left mouse button, and then release the [Ctrl] key.

1. Select the feature that you wish to construct, e.g., Circle. The software displays the Model window.
2. Decide which features you wish to extract. This will affect how they are extracted. For example:
   - Use Control-Clicks in pairs to extract data points in subsets.
   - Use one click on a feature to extract all the data points in that feature.
   - Make sure that you extract the subsets in the same order (direction) in which the points were specified, e.g., left to right, clockwise, counter-clockwise. (See *How Data Extraction Is Done* for more information.)
3. Control-Click on the Start point to begin creating a subset. The software highlights the entire feature in the Model window, automatically checks the Composite check box, and the cursor changes to a cross.
4. Control-Click on the End point to finish creating a subset. The software creates and draws the subset in the picked color, changes the cursor back to normal, and increments the Features counter in the step. The software also grays out the Composite check box when at least one subset is defined.
5. Repeat Steps 3 and 4 if you wish to select other features or subsets.
6. Click **OK** or **Done** (as applicable). The constructed feature is displayed in the Model window as dashed lines and the subsets are no longer highlighted.

When you click on a constructed step to edit it, all of its reference features and subsets are highlighted and the feature itself turns to a bright blue.

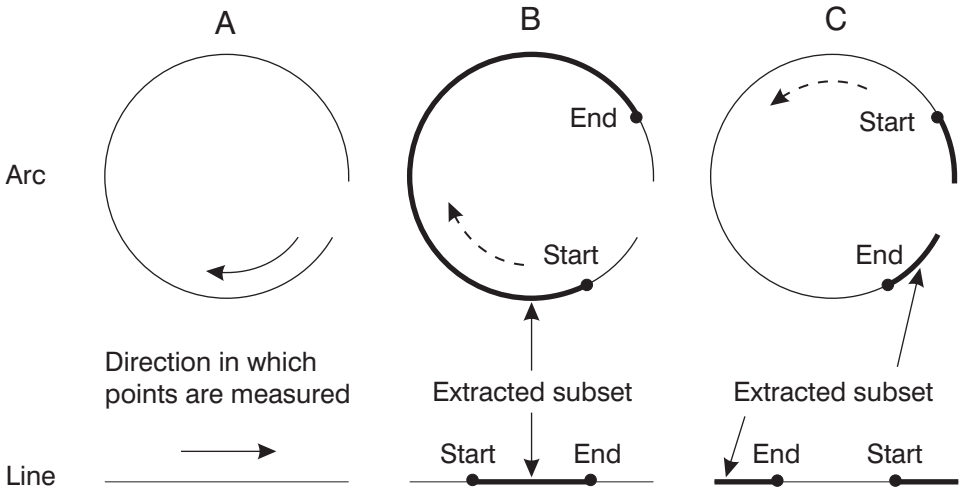
Notes:

1. If the extracted subset is not what was expected, reverse the order of the Start and End points.
2. If you copy an extracted feature, you may also need to copy the reference feature; otherwise the copy may cause an error to occur.

How Data Extraction is Done

The illustration below shows how the software extracts data when you use the data extraction function to specify the Start and End points of a subset for an arc and a line.

- **Figure A**: The data points are measured in a clockwise direction for the arc and a left-to-right direction for the line.
- **Figure B**: When you specify the Start and End points in the direction in which the data points are measured (shown by a dashed arrow), the extracted subset is also created by going in the same direction.
- **Figure C**: When you specify Start and End points in the opposite direction (shown by a dashed arrow) from which the points are measured, the extracted subset is still created by going in the direction in which the data points are measured (shown in Fig. A) rather than the direction in which the Start and End points were specified. If this is not what was expected, the Start and End points should be specified in the opposite direction, i.e., the same direction in which the points are measured.

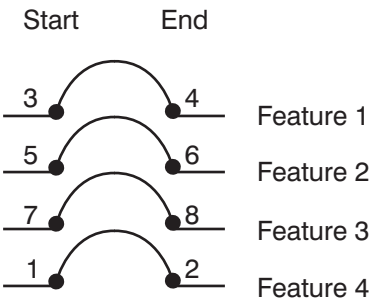


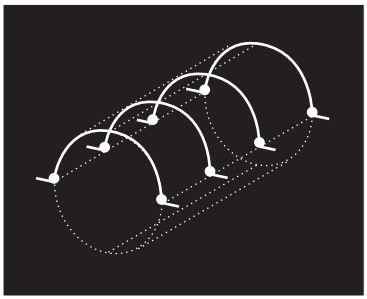
How to Extract a Cylinder from Multiple Features

In the example below, use the Data Extraction function to construct a cylinder using four subsets of points taken from four measured Contour steps.

Note: To perform a Control-Click, press and hold the [Ctrl] key on the keyboard, click the left mouse button, and then release the [Ctrl] key.

1. Select the Construct Cylinder function. The software displays the Model window.
2. Control-Click on the Start point of the first curve segment to begin creating a subset.
   - The first subset needs to be at one end of the cylinder.
   - The software highlights the entire feature in the Model window, automatically checks the Composite check box, and the cursor changes to a cross.
3. Control-Click on the End point of the segment to finish creating a subset. The software creates and draws the subset in the selected color, changes the cursor back to normal, and increments the Features counter in the step. The software also grays out the Composite check box.
4. Repeat Steps 2 and 3 to create subsets from the other three contours.
   - The second subset needs to be at the other end of the cylinder.
   - You can create the remaining two subsets in any desired order.
5. Click **OK** or **Done** (as applicable). The constructed cylinder is displayed in the Model window as dashed lines and subsets are no longer highlighted.





How to Extract a Line from a Single Feature

In the example below, use the Data Extraction function to construct a line using two subsets of points taken from one measured Contour.

Note: To perform a Control-Click, press and hold the [Ctrl] key on the keyboard, click the left mouse button, and then release the [Ctrl] key.

1. Select the Construct Line function. The software displays the Model window.
2. Control-Click on the Start point of the first line segment to begin creating a subset. The software highlights the entire feature in the Model window, automatically checks the Composite check box, and the cursor changes to a cross.
3. Control-Click on the End point of the segment to finish creating a subset. The software creates and draws the subset in the picked color, changes the cursor back to normal, and increments the Features counter in the step. The software also grays out the Composite check box.
4. Repeat Steps 2 and 3 to create a subset from the second line segment.
5. Click **OK** or **Done** (as applicable). The constructed line is displayed in the Model window as dashed lines and the subsets are no longer highlighted.

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Section 6

Replacing the Laser

This section describes how to replace one DRS laser model with another on a system already configured with a DRS laser, and includes information about the laser configuration parameters.

Note: Contact your local authorized OGP representative or call the OGP Sales Department at (585) 544-0400 for information on what DRS laser models are available for your system.

This section describes laser replacement procedures for the following systems:

- SmartScope Quest/Vantage 450, 600, and 650
- SmartScope Quest/Vantage 250 (equipped with a retractable laser slide assembly)
- SmartScope Quest/Vantage 250 (equipped with an adjustable laser slide assembly)
- SmartScope/Avant ZIP and Avant ATS
- Avant Apex

When you replace one laser model with another, you must:

- Change the laser capture range parameter in the laser configuration file for your system (see Appendix A)
- Change the X or Y laser range correction factor if you replace one laser type with another laser type (i.e., change from a specular laser (DRS 300 or 500) to a diffuse laser (DRS 2000) or vice-versa).
- Perform the alignment procedures described in Section 2.

Note: Replacement procedures for SmartScope Flash 250, 300, 400, 500, 600, and 700 systems are **not** documented in this manual. Contact your local authorized OGP Service Representative or the OGP Service Department at (585) 544-0450 for information about replacing a laser on these systems.

The laser on SmartScope Quest/Vantage 450, 600, and 650 systems is retractable, and is located behind the optical assembly, as shown in Figure 6-1.

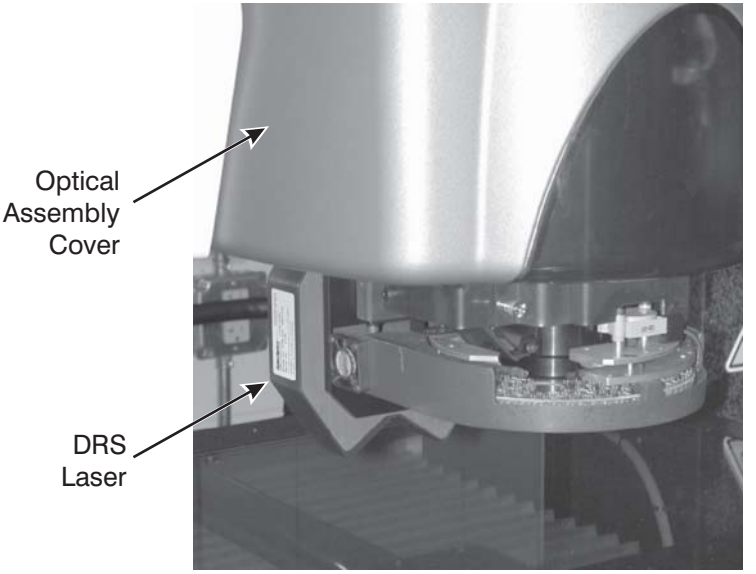

Figure 6-1. Laser Location

Complete the following procedure to replace the laser on SmartScope Quest/Vantage 450, 600, and 650 systems.

Note: Do not remove the laser mounting bracket because it was aligned at the factory, and requires re-alignment if removed.

1. If the laser is retracted, it must be deployed to allow access to the laser cable and the laser mounting screws. To deploy the laser, gently pull down on the laser until you hear a click. If you pull it past the first click, it will "spring" back to the retracted position.
2. Lower the optical assembly along the Z axis as far as possible, without allowing the laser to come in contact with the stage.
3. Exit from MeasureMind 3D and follow the standard lockout procedure described in the service manual for your system.

4. Remove the optical assembly cover.

Note: On SmartScope Vantage systems, the LED PCB is attached to the inside of the cover. It must disconnected in order to remove the cover.

CAUTION: If the system's main power is not turned off, **do not** unplug or connect the laser cable. This could cause permanently damage the DRS laser.

5. Locate and unplug the laser cable, see Figure 6-2.

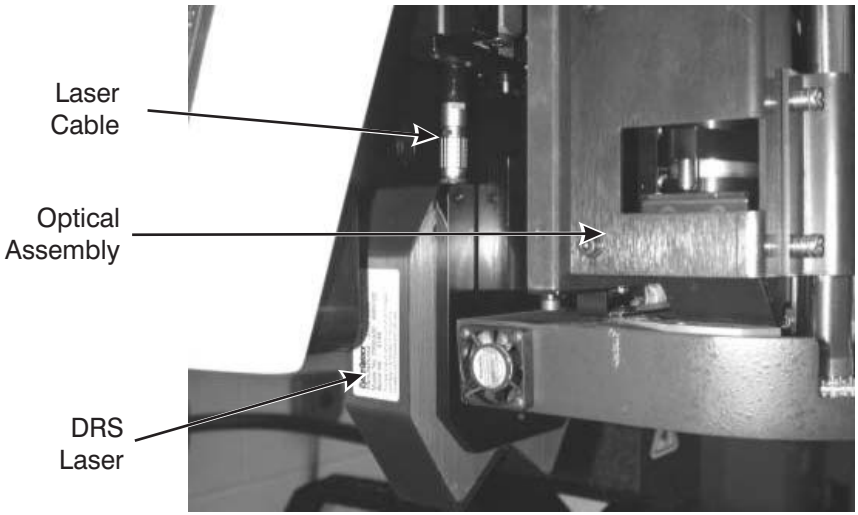

Figure 6-2. Laser Cable

Note: Before removing the laser, it is important to note the location of the laser cable and the orientation of the laser. The replacement laser must be mounted with the same laser cable location and laser orientation.

CAUTION: Hold onto the sensor as you remove the three mounting screws because the sensor could fall and be damaged.

6. Use a 3 mm hex key (Allen) wrench to remove the three mounting screws shown in Figure 6-3.

Note: The mounting screws are only accessible from the back of the machine.

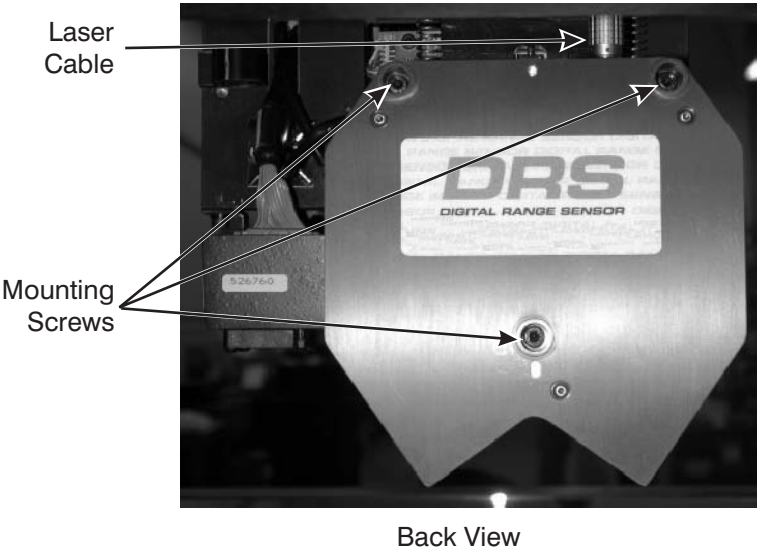

Figure 6-3. Mounting Screws

7. Reverse the above procedure to install the replacement laser.
8. If you replaced one DRS model with another, you need to change the laser capture range parameter in the laser configuration file (described at the end of this section).
9. If you replaced one laser type with another (i.e., change from a specular laser (DRS-300 or 500) to a diffuse laser (DRS-2000) or vice-versa), you need to change either the X or Y laser range correction factor in the laser configuration file (described at the end of this section).
10. Perform both laser alignment procedures described in Section 2.

On SmartScope Quest/Vantage 250 fixed lens systems, the DRS laser is mounted to the left of the optics. On SmartScope Quest/Vantage 250 zoom lens systems, the laser is mounted to the right of the optics, as shown in Figure 6-4.

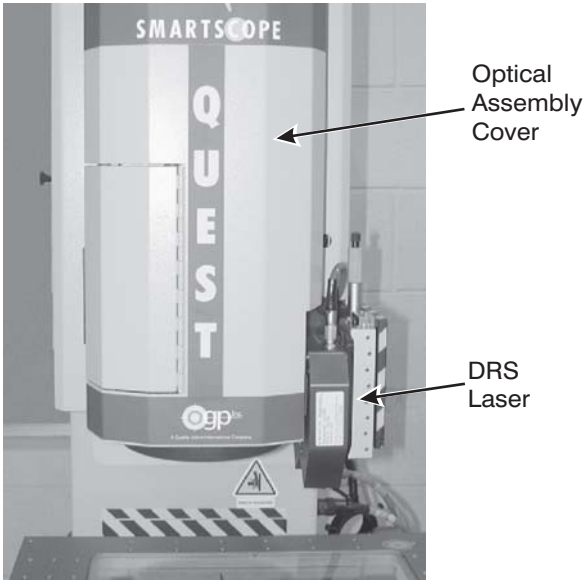

Figure 6-4. SmartScope Quest/Vantage 250 (Zoom Lens)

Note: The procedures in this subsection use the SmartScope Quest/Vantage 250 zoom lens system for illustration purposes. However, the procedures apply to SmartScope Quest/Vantage 250 zoom lens and fixed lens systems.

SmartScope Quest/Vantage 250 systems may be equipped with either a retractable or an adjustable laser slide assembly. Laser replacement procedures for each type of slide assembly are described on the following pages.

Systems with a Retractable Laser Slide Assembly

Follow the steps below to remove and replace the DRS laser on SmartScope Quest/Vantage 250 systems equipped with a retractable laser slide assembly.

1. Lower the optical assembly all the way down and move the stage all the way to the right (zoom lens systems) or left (fixed lens systems).
2. Exit from MeasureMind 3D and follow the standard lockout procedure described in the service manual for your system.
3. Place a clean cloth or sheet of paper on the stage, for protection.

CAUTION: If the system's main power is not turned off, **do not** unplug or connect the laser cable. This could permanently damage the DRS laser.

4. Locate and unplug the laser cable (see Figure 6-5).

CAUTION: Hold onto the laser slide assembly as you remove the three mounting screws because the assembly could fall and damage the laser or stage glass.

5. Hold the laser slide assembly and remove the three screws securing the laser slide assembly to the machine (see Figure 6-5). Use a 2.5 mm hex key (Allen) wrench.

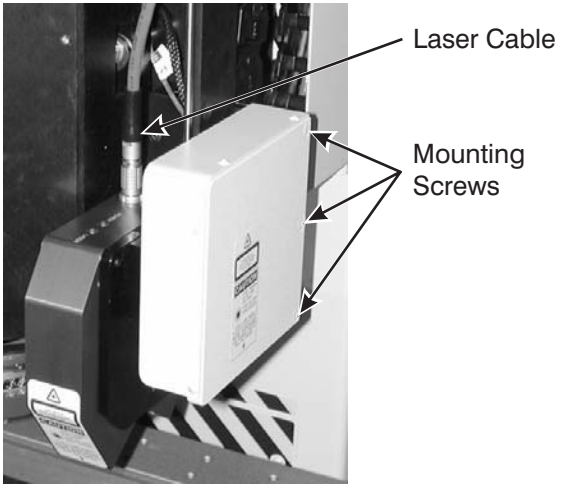

Figure 6-5. Removing the Laser Slide Assembly

6. Place the laser slide assembly onto to the stage, with the laser facing up. Be careful not to strain the attached laser crash cable. Doing so could damage the cable.

Note: Before removing the laser, it is important to note the location of the laser cable and the orientation of the laser. The replacement laser must be mounted with the same laser cable location and laser orientation.

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7. Use a 3 mm hex key (Allen) wrench to remove the three mounting screws securing the DRS laser to the laser slide assembly (see Figure 6-6).

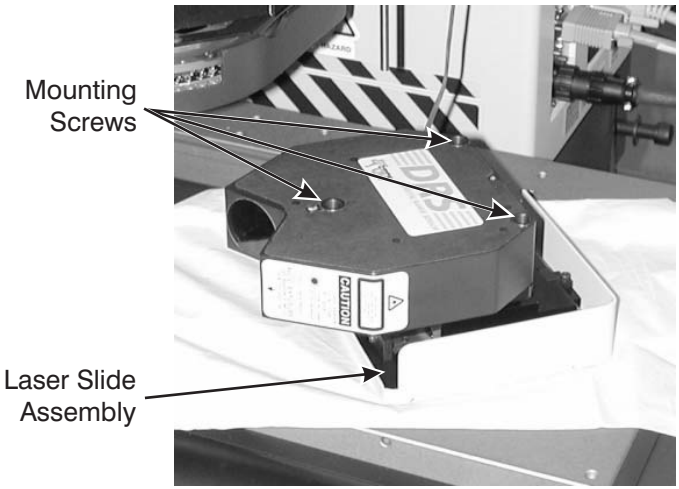

Figure 6-6. Removing the Laser

8. Use a 3 mm hex key (Allen) wrench and the screws removed in the previous step to secure the replacement laser to the laser slide assembly.

CAUTION: When re-installing the retractable laser slide assembly, be careful not to pinch the laser crash cable.

9. Re-install the laser slide assembly.
   - Insert the dowel pin into the upper hole in the guide bracket (see Figure 6-7) and lift the dowel pin all the way up when you mount the laser slide assembly.
   - Carefully feed the laser crash cable through the access hole in the mounting bracket, into the Z axis cover, as you mount the laser slide assembly. Be careful not to pinch the cable between the bracket and laser slide assembly when mounting the laser slide assembly.
   - Make sure the right side (zoom lens systems) or left side (fixed lens systems) of the laser slide assembly is flush with the back surface of the mounting bracket.
   - Use a 2.5 mm hex key (Allen) wrench and the three screws removed in Step 5 to secure the laser slide assembly to the mounting bracket (see Figure 6-5 on page6-6). Make sure that the laser slide assembly and mounting bracket remain aligned as you tighten the mounting screws.
10. Connect the laser cable to the top of the laser (see Figure 6-7).

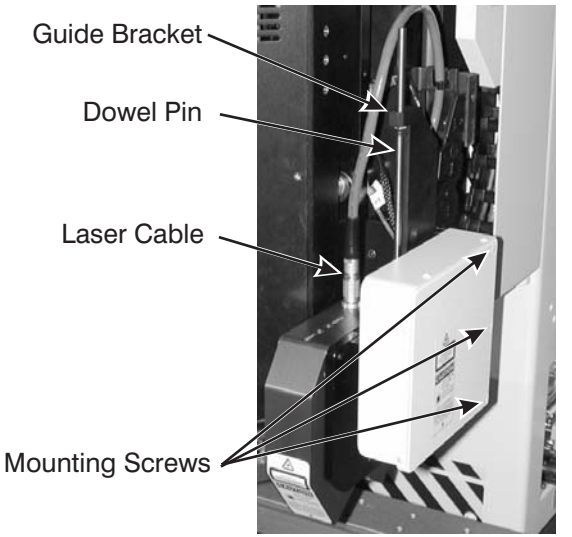

Figure 6-7. Installing the Laser Slide Assembly

11. If you replaced one DRS model with another you need to change the laser capture range parameter in the laser configuration file (described at the end of this section).
12. If you replaced one laser type with another (i.e., change from a specular laser (DRS-300 or 500) to a diffuse laser (DRS-2000) or vice-versa), you need to change either the X or Y laser range correction factor in the laser configuration file (described at the end of this section).
13. Perform the laser alignment procedures described in Section 2.

Systems with an Adjustable Laser Slide Assembly

Follow the steps below to replace a DRS laser on SmartScope Quest/Vantage 250 systems equipped with an adjustable laser slide assembly.

1. Lower the optical assembly all the way down.
2. Exit from MeasureMind 3D and follow the standard lockout procedure described in the service manual for your system.
3. Place a clean cloth or sheet of paper on the stage, for protection.

CAUTION: If the system's main power is not turned off, **do not** unplug or connect the laser cable. This could permanently damage the DRS laser.

4. Locate and unplug the laser cable from the top of the laser (see Figure 6-8).

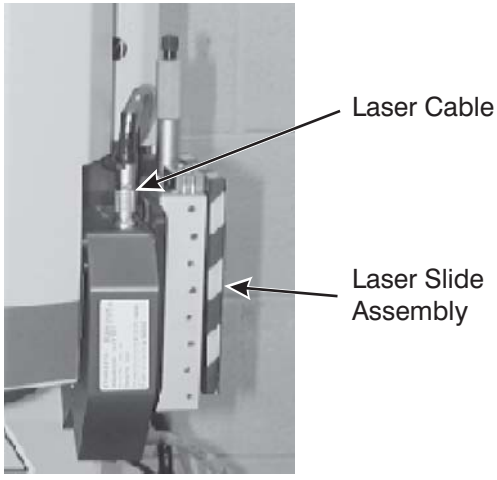

Figure 6-8. Disconnecting the Laser Cable

CAUTION: Hold onto the laser slide assembly as you remove the three mounting screws, because the assembly could fall and damage the laser or stage glass.

5. Hold the laser slide assembly and remove the three screws securing the laser slide assembly to the machine (see Figure 6-9). Use a 2.5 mm hex key (Allen) wrench.

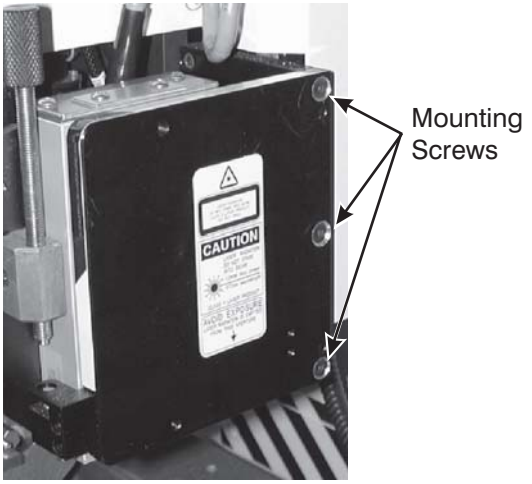

Figure 6-9. Removing the Laser Slide Assembly

Note: Before removing the laser, it is important to note the location of the laser cable and the orientation of the laser. The replacement laser must be mounted with the same laser cable location and laser orientation.

6. Use a 3 mm hex key (Allen) wrench to remove the three mounting screws securing the DRS laser to the laser slide assembly.
7. Reverse the above procedure to install the replacement laser.
   - When re-installing the laser slide assembly, make sure that the right side (zoom lens systems) or left side (fixed lens systems) of the laser slide assembly is flush with the back surface of the mounting bracket.
8. If you replaced one DRS model with another you need to change the laser capture range parameter in the laser configuration file (described at the end of this section).
9. If you replaced one laser type with another (i.e., change from a specular laser (DRS-300 or 500) to a diffuse laser (DRS-2000) or vice-versa), you need to change either the X or Y laser range correction factor in the laser configuration file (described at the end of this section).
10. Perform the laser alignment procedures described in Section 2.

On SmartScope/Avant ZIP and Avant ATS systems the laser is located to the left of the optical assembly, as shown in Figure 6-10.

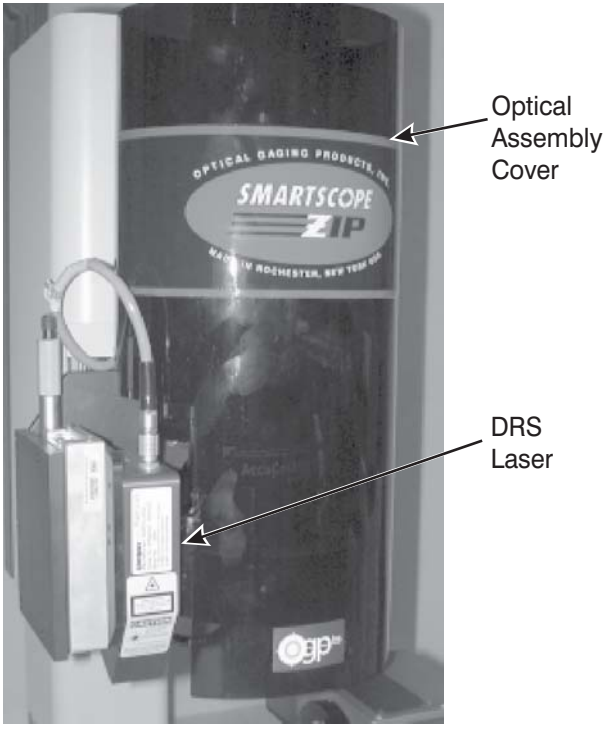

Figure 6-10. Laser Location

To replace the laser on SmartScope/Avant ZIP, and Avant ATS systems equipped with a SmartRing Light, you must first remove the SmartRing Light to gain full access to the laser and its mounting screws.

Note: Do not remove the laser mounting bracket because it was aligned at the factory, and requires re-alignment if removed.

The procedure for removing the standard SmartRing Light is described on the next page, and is followed by the procedure for removing the Horizon I SmartRing Light.

If you do not have a SmartRing Light installed on your system, skip the SmartRing Light removal procedures and see page 6-10 for the laser replacement procedure.

SmartRing Light

Complete the following steps to remove the SmartRing Light on SmartScope/Avant ZIP and Avant ATS systems.

1. Raise or lower the optical assembly along the Z axis to a comfortable height.
2. Exit from the metrology software and perform the standard lockout procedure described in the service manual for your system.

CAUTION: If the power is not turned off, this could cause permanent damage to the SmartRing Light. For example, thermal thresholds may get reset causing the light to overheat and circuits controlling the LEDs may get destroyed.

3. Remove the optical assembly cover and locate the standard SmartRing Light.
4. If the standard fiberoptic ring light is installed, it must be removed and placed on the ring light docking port.
   - Loosen the three screws on the ring light and remove it from the spacer tube.
   - Place the ring light on the ring light docking port (on the column) and tighten the three screws to secure the ring light onto the ring light docking port.

Note: To protect the ring light make sure that the light source faces in, toward the column.

5. If a spacer tube is installed at the bottom of the optics:
   - Unscrew the spacer tube from the collar tube by turning it in a counterclockwise direction.
   - Screw the spacer tube into the ring light docking tube.
6. Unscrew and unplug the power connector in the back of the SmartRing Light.
7. Using a 5.5 mm hex key (Allen) wrench, unscrew the grounding screw and remove the ground wire. Screw the grounding screw, lock and star washers back into the SmartRing Light.
8. Using 1.5 mm hex key (Allen) wrench, loosen the two set screws in the collar (located on the left and in the back).
9. While holding the Smart Ring Light in place, carefully unscrew the thumbscrew that secures the “L” bracket to the zoom lens housing.
10. Carefully remove the SmartRing Light and store it in cool, dry place.

11. When you are ready, reverse the above procedure to re-install the SmartRing Light.

Proceed to the following page, and follow the laser replacement procedure.

Horizon I SmartRing Light

Complete the following steps to remove the Horizon I SmartRing Light on SmartScope/Avant ZIP and Avant ATS systems.

1. Raise or lower the optical assembly along the Z axis to a comfortable height.
2. Exit from the metrology software and perform the standard lockout procedure described in the service manual for your system.

CAUTION: If the power is not turned off, this could cause permanent damage to the SmartRing Light. For example, thermal thresholds may get reset causing the light to overheat and circuits controlling the LEDs may get destroyed.

3. Remove the optical assembly cover and locate the Horizon I SmartRing Light.
4. Unscrew and unplug the power connector in the back of the Horizon I SmartRing Light.
5. Using a 5.5 mm hex key (Allen) wrench, unscrew the grounding screw and remove the ground wire. Screw the grounding screw, lock and star washers back into the Horizon I SmartRing Light.
6. Remove the cover that is over the three lamps, which is secured by Phillips head screws.
7. Using a 2 mm hex key (Allen) wrench, loosen the set screw of the left-most fiberoptic bundle at the top of the machine and pull the bundle out of the socket. This bundle is connected to the Horizon I SmartRing Light.
8. Remove the bundle. Follow the path behind the optical housing.
9. While holding the Horizon I SmartRing Light in place, carefully unscrew the thumb screw that secures the “L” bracket to the zoom lens housing.
10. Carefully remove the Horizon I SmartRing Light and store it in a cool, dry place.
11. When you are ready, reverse the above procedure to re-install the Horizon I SmartRing Light.

Proceed to the following page, and follow the laser replacement procedure.

Laser Replacement

Complete the following steps to replace the laser on SmartScope/Avant ZIP and Avant ATS systems. If this is being done immediately following the removal of a SmartRing Light or Horizon I SmartRing Light, you can skip Steps 1 through 3.

Note: Do not remove the laser mounting bracket. It was aligned at the factory, and requires re-alignment if removed.

1. Raise or lower the optical assembly along the Z axis to a comfortable height.
2. Exit from the metrology software and perform the standard lockout procedure described in the service manual for your system.
3. Remove the optical assembly cover.
    - If a SmartRing Light is installed, it must be removed to continue (described earlier).

CAUTION: If the system's main power is not turned off, **do not** unplug or connect the laser cable. This could permanently damage the DRS laser.

4. Locate and unplug the laser cable, see Figure 6-11 on the following page.

Note: Before removing the laser, it is important to note the location of the laser cable and the orientation of the laser. The replacement laser must be mounted with the same laser cable location and laser orientation.

CAUTION: Hold onto the sensor as you remove the three mounting screws because the sensor could fall and be damaged.

5. Use a 3 mm hex key (Allen) wrench to remove the three mounting screws shown in Figure 6-11.

Figure 6-11. Mounting Screws (SmartRing Light removed)

6. Reverse the above procedure to install the replacement laser.
7. If you replaced one DRS model with another you need to change the laser capture range parameter in the laser configuration file (described at the end of this section).
8. If you replaced one laser type with another (i.e., change from a specular laser (DRS-300 or 500) to a diffuse laser (DRS-2000) or vice-versa), you need to change either the X or Y laser range correction factor in the laser configuration file (described at the end of this section).
9. Perform the laser alignment procedures described in Section 2.

On the Avant Apex system, the laser is located directly behind the optical assembly, as shown in Figure 6-12. You must first remove the optical assembly to gain access to the laser.

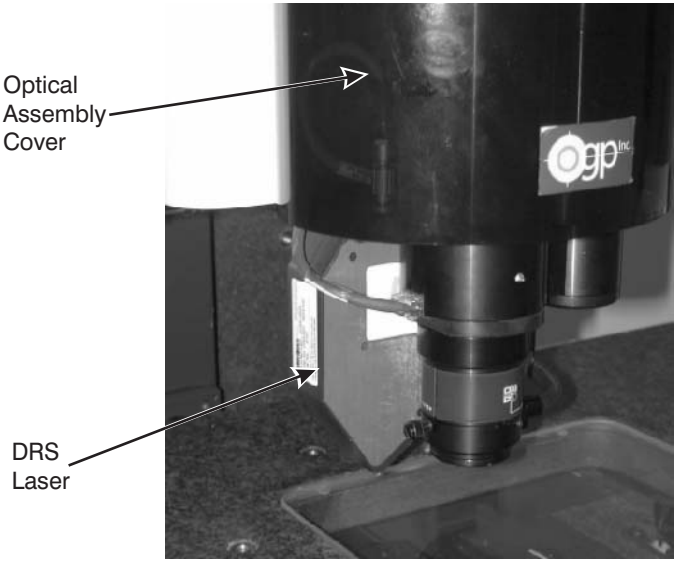

Figure 6-12. Laser Location

Complete the following steps to replace a DRS laser on an Avant Apex system.

1. Raise or lower the optical assembly along the Z axis to a comfortable height.
2. Exit from the metrology software and perform the standard lockout procedure described in the service manual for your system.

3. Remove the optical assembly cover, to access the optical assembly.

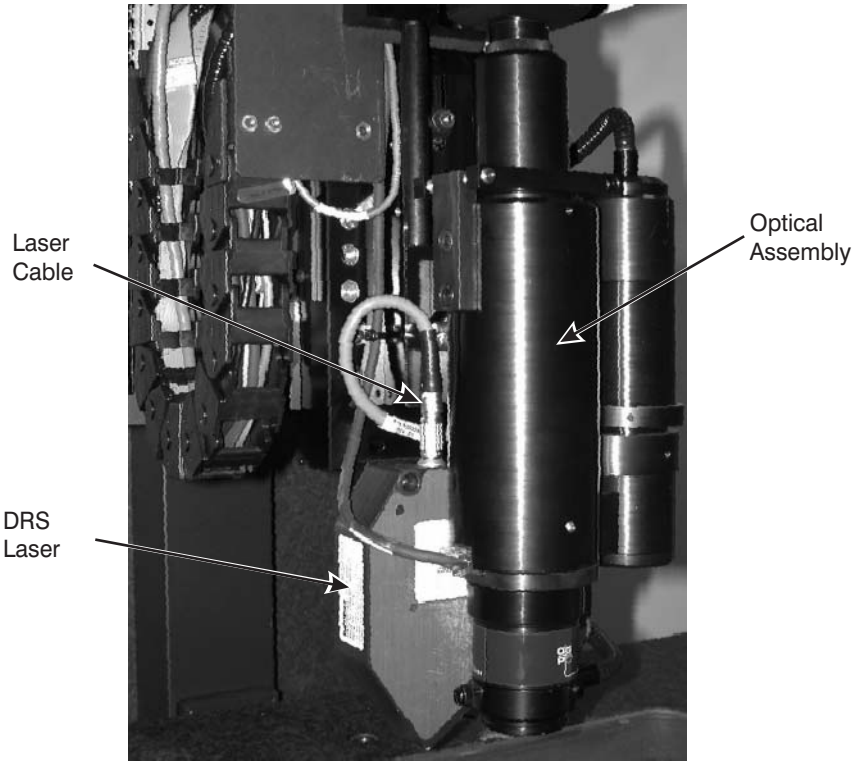

Figure 6-13. Optical Assembly (cover removed)

4. Using a 0.5 mm hex key (Allen) wrench, loosen the camera cover set screw, raise the cover, and retighten the set screw, see Figure 6-14.
5. Using a 4 mm hex key (Allen) wrench, loosen the optical assembly set screw, see Figure 6-14.

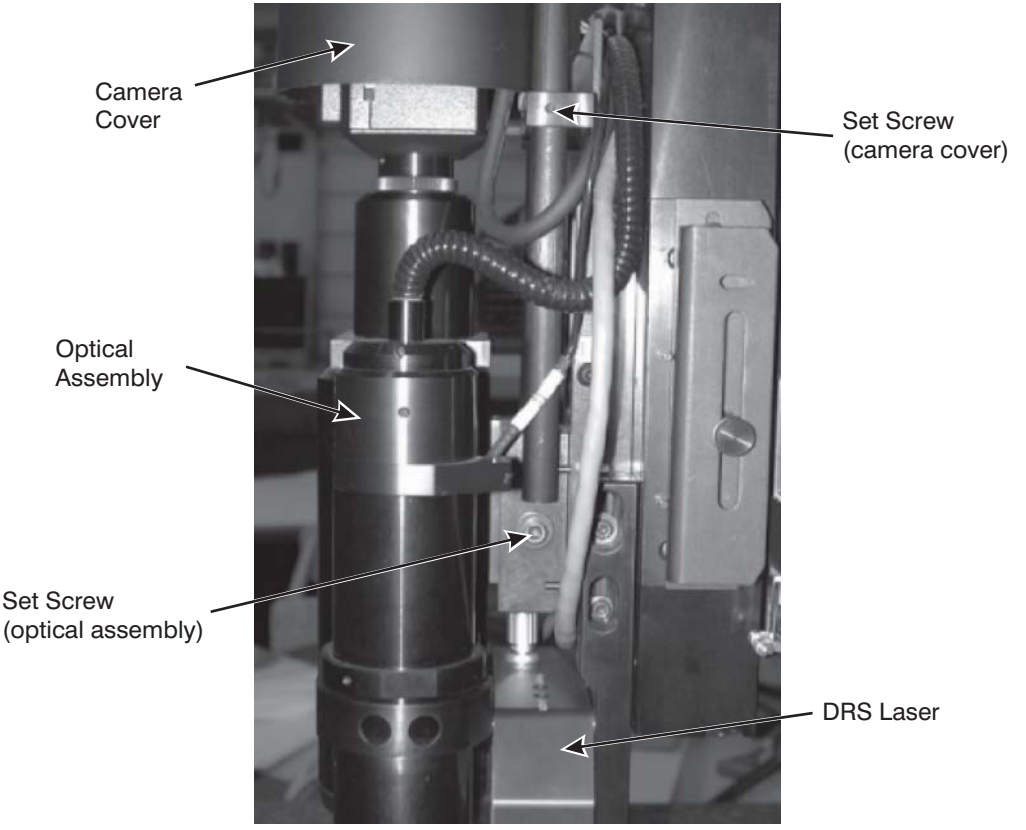

Figure 6-14. Optical Assembly Set Screws

6. Remove the fiberoptic ring light, see Figure 6-15.
7. Unplug the optical cable and remove the optical assembly by sliding it in the direction of the arrow shown in Figure 6-15.

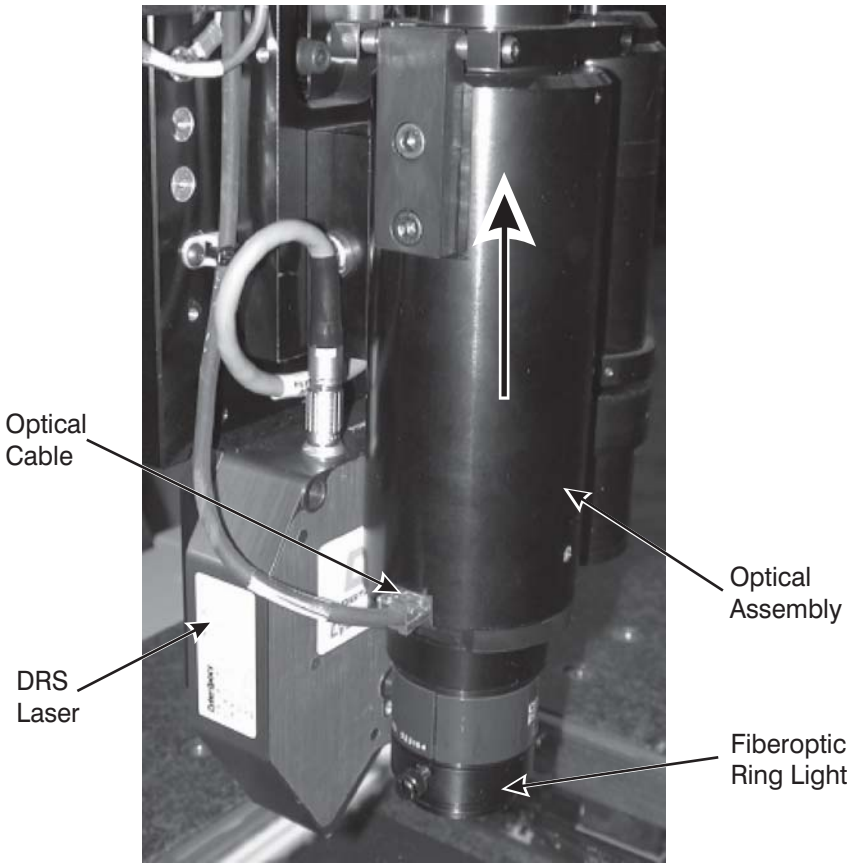

Figure 6-15. Optical Assembly

Now that the optical assembly has been removed, you have full access to the laser and its mounting screws.

Note: Do not remove the laser mounting bracket. It was aligned at the factory, and requires re-alignment if removed.

CAUTION: If the system's main power is not turned off, **do not** unplug or connect the laser cable. This could permanently damage the DRS laser.

8. Locate and unplug the laser cable, see Figure 6-16.

Note: Before removing the laser, it is important to note the location of the laser cable and the orientation of the laser. The replacement laser must be mounted with the same laser cable location and laser orientation.

CAUTION: Hold onto the sensor when you remove the 3 mounting screws because the sensor could fall and be damaged.

9. Using a 3 mm hex key (Allen) wrench, remove the three laser mounting screws shown in Figure 6-16.

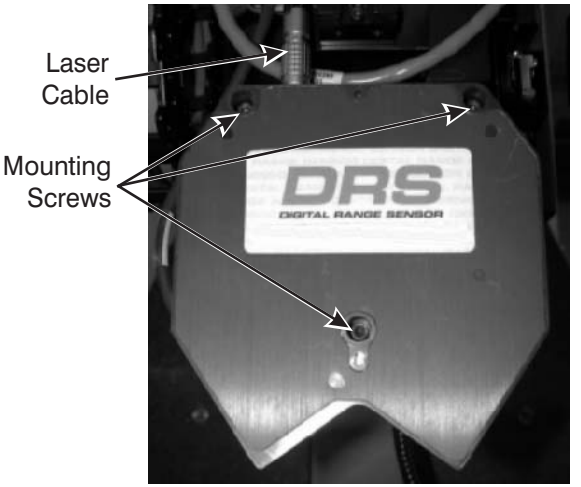

Figure 6-16. Mounting Screws

10. Reverse the above procedure to install the replacement laser.
11. If you replaced one DRS model with another you need to change the laser capture range parameter in the laser configuration file (described at the end of this section).
12. If you replaced one laser type with another (i.e., change from a specular laser (DRS-300 or 500) to a diffuse laser (DRS-2000) or vice-versa), you need to change either the X or Y laser range correction factor in the laser configuration file (described at the end of this section).
13. Perform the laser alignment procedures described in Section 2.

Laser Configuration Parameters

This subsection includes information related to the laser range correction factor and laser capture range parameters.

Laser Range Correction Factors

When you replace one laser type with another (i.e., change from a specular laser (DRS-300 or 500) to a diffuse laser (DRS-2000) or vice-versa), you must change one of the following parameters before using the laser:

- LASER X_LASER_RANGE_CORRECTION_FACTOR
- LASER Y_LASER_RANGE_CORRECTION_FACTOR

These parameters are located in the following configuration file for your system:

- The LASER.CFG file for MeasureMind 3D systems, which is located in the following directory: C:\OGPMM\CONFIG
- The CALIBRATION.INI file for Measure-X systems, which is located in the following directory: C:\OGP\MEASURE-X\CONFIG

Notes:

1. The values for the above parameters are dependent on the DRS model, the mounting location, and the orientation of the laser.
2. You must save the configuration file before exiting for any changes to take effect.
3. The LASER Z_LASER_RANGE_CORRECTION_FACTOR parameter should always be set to 1.0.
4. In Measure-X, you can access the laser range correction factor parameters in the System Configuration Parameter Editor. To do so, select **System / Configuration ⇒ Editor**, and then select **Laser Calibration** from the drop-down list.

The following page provides the correct laser range correction settings.

DRS-300 and DRS-500

If the laser is mounted parallel to the Y axis, set the corrections factor based on the orientation of the laser, as described below.

- With the **laser cable towards the back** of the machine, the following parameters should be set:
  - LASER X_LASER_RANGE_CORRECTION_FACTOR **0.00000**
  - LASER Y_LASER_RANGE_CORRECTION_FACTOR **-0.70020**
- With the **laser cable towards the front** of the machine, the following parameters should be set:
  - LASER X_LASER_RANGE_CORRECTION_FACTOR **0.00000**
  - LASER Y_LASER_RANGE_CORRECTION_FACTOR **0.70020**

If the laser is mounted parallel to the X axis, set the corrections factor based on the orientation of the laser, as described below.

- With the **laser cable towards the left** of the machine, the following parameters should be set:
  - LASER X_LASER_RANGE_CORRECTION_FACTOR **0.70020**
  - LASER Y_LASER_RANGE_CORRECTION_FACTOR **0.00000**
- With the **laser cable towards the right** of the machine, the following parameters should set:
  - LASER X_LASER_RANGE_CORRECTION_FACTOR **-0.70020**
  - LASER Y_LASER_RANGE_CORRECTION_FACTOR **0.00000**

DRS-2000

For the DRS-2000 model laser, the X and Y correction factors should always be set to 0, regardless of how it is mounted.

- LASER X_LASER_RANGE_CORRECTION_FACTOR **0.00000**
- LASER Y_LASER_RANGE_CORRECTION_FACTOR **0.00000**

Laser Capture Range

Whenever you replace one DRS laser model with another, you must change the LASER SENSOR_CAPTURE_RANGE parameter before using the laser

This parameter is located in the following configuration file for your system:

- The LASER.CFG file for MeasureMind 3D systems, which is located in the following directory: C:\OGPMM\CONFIG
- The CONFIGURATION.INI file for Measure-X systems, which is located in the following directory: C:\OGP\MEASURE-X\CONFIG

Notes:

1. You must save the configuration file before exiting for any changes to take effect.
2. In Measure-X, you can access the laser capture range parameter in the System Configuration Parameter Editor. To do so, select **System / Configuration ⇒ Editor**, and then select **Laser General** from the drop-down list.

The following table provides the correct capture range values for each of the three DRS models.

Note: The DRS laser model number is the sensor's capture range in microns. For example, the DRS-300 has a capture range of 300 microns. Changing the sensor capture range in the laser configuration file does not change the range of the DRS laser, it only affects the scaling of measurements.

Model	Capture Range Value
DRS-300	300
DRS-500	500
DRS-2000	2000

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Section 7

Maintaining the Laser

To ensure continued high performance, we recommend that you periodically clean the DRS laser sensor. You want to keep dust, dirt, particulate matter, and moisture away from the sensor lenses.

If dirt collects on the lens, gently brush it away with a quality lens brush. Then clean the lens using isopropyl alcohol and a lens cleaning tissue.

CAUTION: Be careful not to use too much alcohol, which might get behind the lens.

CAUTION: Do not rub too hard or you might scratch the surface of the lens.

CAUTION: Use alcohol only when cleaning the sensor lens. You should clean the rest of the DRS laser with a damp, lint-free towel because alcohol may damage labels.

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Appendix A

Tutorials (Measure-X Systems)

This appendix contains four tutorials designed to help you become more familiar with the functionality of the DRS laser on a system equipped with Measure-X.

Note: This appendix only applies to systems equipped with the Measure-X software. Appendix B contains tutorials that apply to systems equipped with the MeasureMind 3D software.

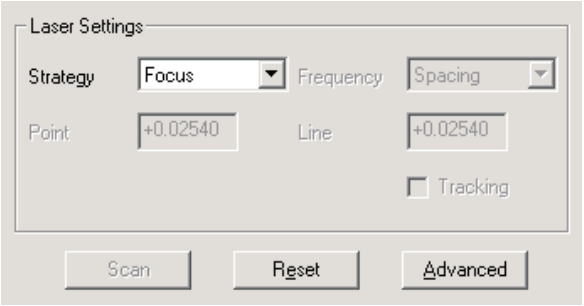
Using the Laser Focus Function to Perform an Autofocus

Follow the steps below to practice using the laser focus function. In this tutorial, you will perform an autofocus on the surface of the QVI training part (P/N 790012).

Before you begin, select the lowest magnification level for ease of locating features. Laser accuracy is independent of magnification level.

1. Position the QVI training part squarely on the stage.
2. Click the **Laser** icon in the toolbox or select **Laser** in the **Tools** menu to select the Laser tool.

3. In the Laser Settings window, select **Focus** in the **Strategy** list. The software displays the laser focus target, which appears as a circle with four "handles" in the center of the Image window.



4. Using the joystick, move the stage so that a surface on the QVI training part appears in the center of the Image window.
5. Turn off the back light and turn on the surface illumination to approximately 45%.
6. Twist the Z axis fine adjustment knob on top of the joystick until the surface is in best focus.
7. In the DRO window, click **Z** to zero the Z axis readout.

WARNING: To prevent hazardous radiation exposure to your eyes, do not look directly at the laser beam while operating the laser.

8. Click inside the circle to perform the laser focus. The system moves the laser to the optics location, turns off the video illumination, performs a laser focus (which is indicated by a flash of the blue Laser Indicator LED), and obtains a focus point.
   - If it is not successful on the first attempt, it will continue trying in increments of 90% of the capture range for the number of attempts specified in the LASER.INI file. In this case, it moves the stage in the second attempt, depending on the configuration settings.
   - If it fails, twist the joystick knob until the focus is within the range and click inside the laser target to perform the focus manually. If you wish, you can also use the sensor graph.
   - If you place the cursor outside the circle and click the left mouse button, the system moves the laser to the center of the circle. You must then click inside the circle to obtain a focus point.
   - After the laser focus is completed, the software displays the found Z location above the light level in the lower-left corner of the Image window. If the focus is successful, you will hear a "beep."
9. Look at the Z value displayed in the DRO window. This indicates the difference between a visual focus and an autofocus with the Laser tool.

Using the Laser Focus Function to Measure a Plane

Follow the steps below to practice using the laser focus function to measure a feature. In this tutorial, you will perform an autofocus with the Laser tool near the lower-right, the lower-left, and the upper-left holes on the QVI training part (P/N 790012) to measure a plane.

Before you begin, select the lowest magnification level to locate features more easily. Laser accuracy is independent of magnification level.

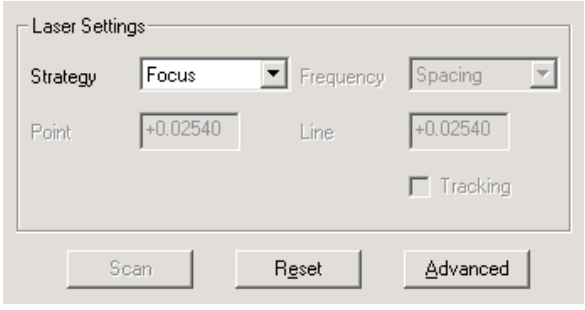
Note: If you are performing this tutorial directly after the previous tutorial, *Using the Laser Focus Function to Perform an Autofocus*, skip Steps 1 through 3.

---

1. Position the QVI training part squarely on the stage.

2. Click the **Laser** icon in the toolbox or select **Laser** in the **Tools** menu to select the Laser tool.

3. In the Laser Settings window, select **Focus** in the **Strategy** list. The software displays the laser focus target, which appears as a circle with four "handles" in the center of the Image window.



4. Click the **Measure** tab and the **Plane** icon or select **Plane** in the **Measure** menu.

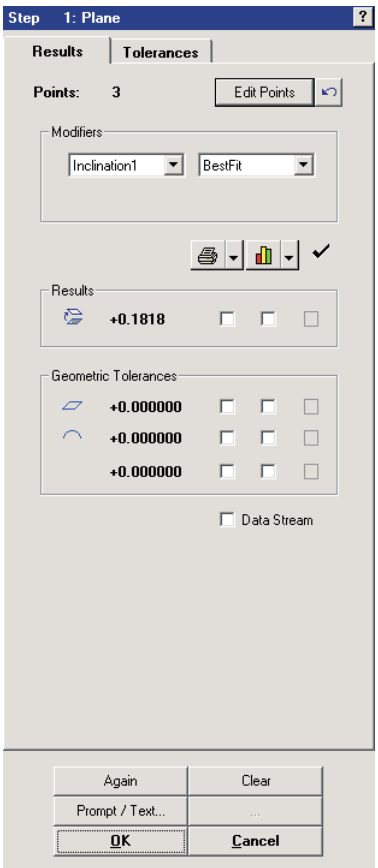
5. Turn off the back light and turn on the surface illumination to approximately 45%.

6. Using the joystick, move the stage so that a surface near the lower-right hole is in the middle of the Image window and twist the Z axis fine adjustment knob on top of the joystick until the surface is in best focus.

WARNING: To prevent hazardous radiation exposure to your eyes, do not look directly at the laser beam while operating the laser.

7. Perform a laser focus on the surface and then press **Enter** on the joystick to accept the focus point.
8. Using the joystick, move the stage so that a surface near the lower-left hole is in the middle of the Image window
9. Perform a laser focus and then press **Enter** on the joystick to accept the point.
10. Using the joystick, move the stage so that a surface near the upper-left hole is in the middle of the Image window, and then repeat Step 9.

    The software displays the results of the plane measurement in the Measurement window.
11. In the Measurement window, click **OK** to complete the step.



Using the Linear Scan Function to Measure a Contour

Follow the steps below to practice using the linear laser scan function. In this tutorial, you will measure a contour on the surface of a penny.

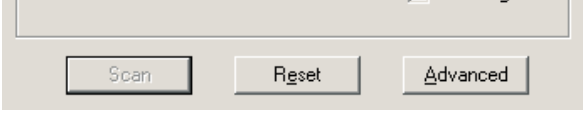
1. Position a penny on the stage so that the Lincoln Memorial side of the penny is up and the memorial is parallel to the X axis.
2. Zoom to the *lowest* magnification to locate features more easily.

Note: Laser accuracy is independent of magnification level. The optics can be anywhere within the zoom range when using the laser.

---

3. Turn off the backlight and turn on the surface illumination to approximately 45%.

4. Click the **Laser** icon in the toolbox or select **Laser** in the **Tools** menu to select the Laser tool.
5. Using the joystick, move the stage so that the left side of the Lincoln Memorial is in the middle of the Image window and make sure the Image is in focus. If it is not, focus the image manually by rotating the Z axis fine adjustment knob on top of the joystick.
6. In the Laser Settings window:
   - Select **Linear Scan** in the Strategy list
   - Select **Spacing** in the Frequency list and then type **0.0254** in the Point box
   - Select the **Tracking** check box



7. Click **Advanced** to display the Advanced Laser Settings window.
8. Select the **Focus First** check box, and then click **OK** to close the window.

Note: Typically, you want both Tracking and Focus First turned on before starting a scan, so that the software performs an autofocus at the start of the scan and attempts to keep the feature centered within the capture range of the laser throughout the scan.

9. Click the **Measure** tab and the **Contour** icon or select **Contour** in the **Measure** menu.
10. Click next to the left end of the Lincoln Memorial to specify the start point of the laser scan (see below).
11. Using the joystick, move the stage so that the right side of the Lincoln Memorial is in the middle of the Image window and click next to the right end to specify the end point of the laser scan (see below).

The software displays the following information at the bottom of the Image window:

- the approximate time it will take for the scan to be completed (T)
- the number of points that the laser is expected to scan (P)
- the number of points selected to initiate the scan

WARNING: To prevent hazardous radiation exposure to your eyes, do not look directly at the laser beam while operating the laser.

12. Click the last point again (place the cursor exactly on the point) or click **Scan** in the Laser Settings window to begin the laser scan. The systems moves the laser to the optics location, turns off the video illumination and performs the scan.

Note: The blue Laser Indicator LED on the front cover flashes as the laser takes height measurements.

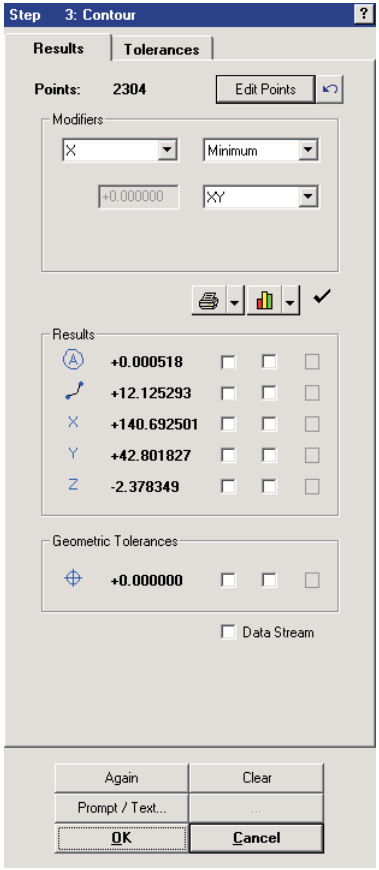
Note: You can stop the scan at any time by pressing the **Stop/Start** button.

The results of the contour measurement are displayed in the Measurement window when the scan is finished.

13. Compare the number of expected points with the actual number of points in the step. If the values differ by more than 10%, determine the reason for the difference, e.g., significant Z height variations, and evaluate whether the scan should be repeated with different parameters.

Note: If you want to repeat the scan with different parameters, simply change the desired settings and click **Scan** in the Laser Settings window.

14. In the Measurement window, click **OK** to complete the step.



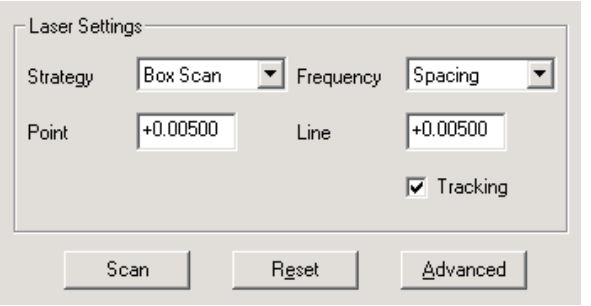
Using the Box Scan Function to Create a Profile

Follow the steps below to practice using the Box scan function. In this tutorial, you will perform a Box scan to create a profile of the Lincoln Memorial on a penny.

Note: If you are performing this tutorial directly after the previous tutorial, *Using the Linear Scan Function to Measure a Contour*, skip Steps 1 through 4.

1. Position a penny on the stage so that the Lincoln Memorial side is up and the memorial is parallel to X axis.
2. Zoom to the *lowest* magnification to locate features more easily.
3. Turn off the backlight and turn on the surface illumination to approximately 45%.

4. Click the **Laser** icon in the toolbox or select **Laser** in the **Tools** menu to select the Laser tool.
5. Using the joystick, move the stage so that the left side of the penny is in the middle of the Image window and make sure the image is in focus. If it is not, focus the image manually by rotating the Z axis fine adjustment knob on top of the joystick.
6. In the Laser Settings window:
   - Select **Box Scan** in the Strategy list
   - Select **Spacing** in the Frequency list and the type **0.005** in the Point and Line boxes
   - Select the **Tracking** check box

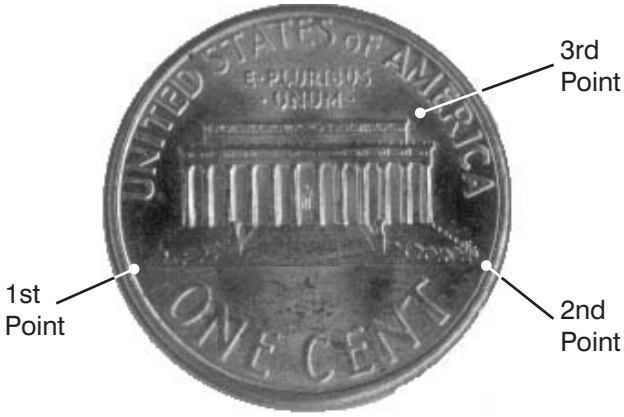


7. Click **Advanced** to display the Advanced Laser Settings window.
8. Select the **Focus First** check box, and then click **OK** to close the window.

Note: Typically, you want both Tracking and Focus First turned on before starting a scan so that the software performs an autofocus at the start of the scan and attempts to keep the feature centered within the laser's capture range throughout the scan.

---

9. In the Image window, click near the lower-left corner of the Lincoln Memorial (see below) to define the starting point of the scan.
10. Using the joystick, move the stage so that the right side of the penny is in the center of the Image window and click near the lower-right corner of the Lincoln Memorial (see below) to define the end point of the first linear scan and the orientation of the box scan length.
11. Click near the upper-right corner of the Lincoln Memorial (see below) to define the location of the last linear scan and the width of the box scan.



The software displays the following at the bottom of the Image window:

- the approximate time it will take for the scan to be completed (T)
- the number of points that the laser is expected to scan (P)
- the number of points selected to initiate the scan

WARNING: To prevent hazardous radiation exposure to your eyes, do not look directly at the laser beam while operating the laser.

12. Click the last point again (place the cursor exactly on the point) or click **Scan** in the Laser Settings window to begin the laser scan. The system moves the laser to the optics location, turns off the video illumination, displays the Surface window, and scans the feature.

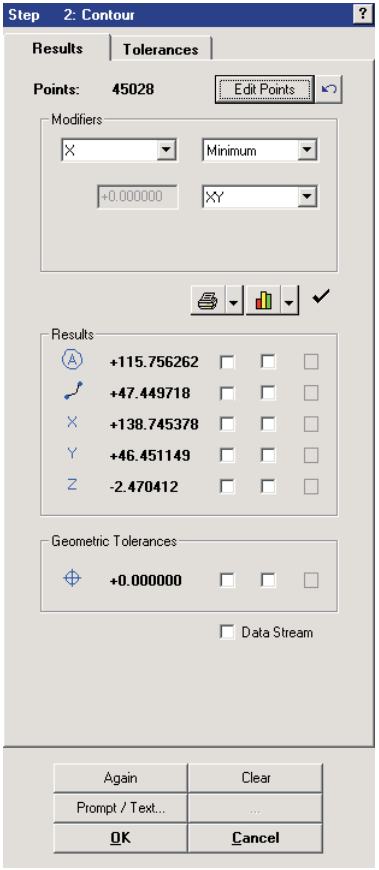
Note: The blue Laser Indicator LED on the front cover flashes as the laser takes height measurements.

The surface is constructed in the Surface window as the laser performs the scan. You can manipulate the surface using the icons in the Surface Control window or the mouse (see Section 4 for more information).

Note: You can stop the scan at any time by pressing the **Stop/Start** button.

When the scan is finished, the software displays the results of the Box scan in the Measurement window.

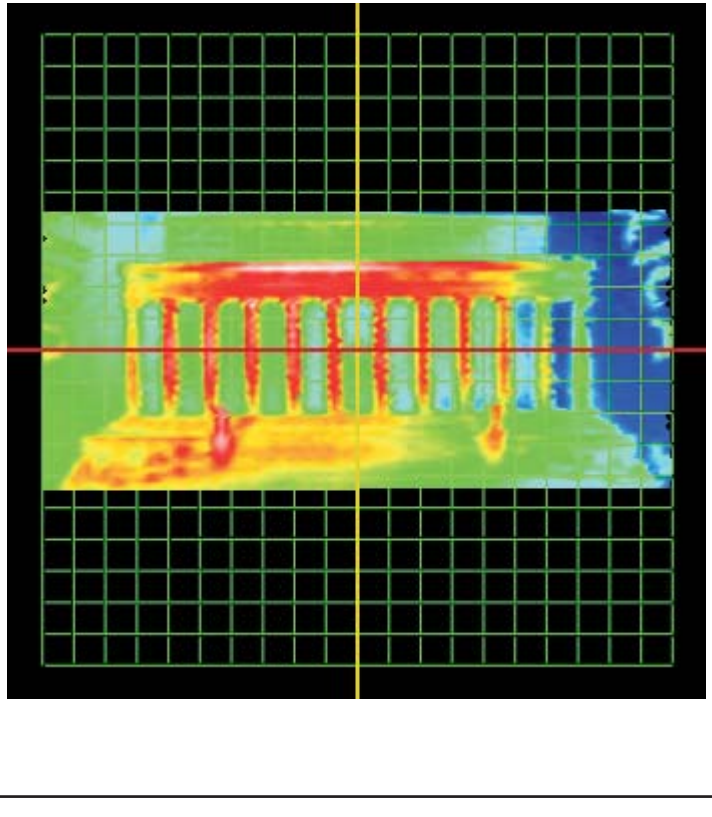
13. Compare the number of expected points with the actual number of points included in the step. If the values differ by more 10%, determine the reason for the difference, e.g., significant Z height variations, and evaluate whether the scan should be repeated with different parameters.



Note: If you want to repeat the scan with different parameters, simply change the desired settings and click **Scan** in the Laser Settings window.

14. In the Measurement window, click **OK** to complete the step.
15. Click the **Model** window tab and select the profile you just created. Then click the **Surface Window** icon to view the surface.

    You should see something similar to the following:



Note: You can manipulate the surface using the icons in the Surface window toolbar or the mouse (see Section 4 for more information).

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Appendix B

Tutorials (MeasureMind 3D Systems)

This appendix contains the following four tutorials designed to help you become more familiar with the functionality of the DRS laser on a system equipped with MeasureMind 3D.

Note: This appendix only applies to systems equipped with the MeasureMind 3D software. Appendix A contains tutorials that apply to systems equipped with the Measure-X software.

Using the Laser Focus Function to Perform an Autofocus

Follow the steps below to practice using the laser focus function. In this tutorial, you will use the Laser Focus target to perform an autofocus on the surface of the QVI training part (P/N 790012).

Before you begin, select the lowest magnification level for ease of locating features. Laser accuracy is independent of magnification level.

1. Position the QVI training part squarely on the stage.

2. Click the **Laser Focus** icon or select **Laser** ⇒ **Focus** in the **Targets** menu to select the Laser Focus target.
3. Using the joystick, move the stage so that a surface on the QVI training part appears in the center of the Image window.
4. Turn off the back light and turn on the surface illumination to approximately 45%.
5. Twist the Z axis fine adjustment knob on top of the joystick until the surface is in best focus.
6. In the DRO window, click **Z** to zero the Z axis readout.

WARNING: To prevent hazardous radiation exposure to your eyes, do not look directly at the laser beam while operating the laser.

7. Click inside the circle to perform the laser focus. The system moves the laser to the optics location, turns off the video illumination, performs a laser focus (which is indicated by a flash of the blue Laser Indicator LED), and obtains a focus point.
   - If it is not successful on the first attempt, it will continue trying in increments of 90% of the capture range for the number of attempts specified in the LASER.CFG file. In this case, it moves the stage in the second attempt, depending on the configuration settings.
   - If it fails, twist the joystick knob until the focus is within the range and click inside the laser target to perform the focus manually. If you wish, you can also use the sensor graph.
   - If you place the cursor outside the circle and click the left mouse button, the system moves the laser to the center of the circle. You must then click inside the circle to obtain a focus point.
   - After the laser focus is completed, the software displays the found Z location above the light level in the lower-left corner of the Image window. If the focus is successful, you will hear a “beep.”
8. Look at the Z value displayed in the DRO window. This indicates the difference between a visual focus and an autofocus with the Laser Focus target.

Using the Laser Focus Function to Measure a Plane

Follow the steps below to practice using the laser focus function to measure a feature. In this tutorial, you will use the Laser Focus target to perform an autofocus near the lower-right, the lower-left, and the upper-left holes on the QVI training part (P/N 790012) to measure a plane.

Note: If you are performing this tutorial directly after the previous tutorial, *Using the Laser Focus Function to Perform an Autofocus*, skip Steps 1 through 3.

---

1. Position the QVI training part squarely on the stage.
2. Zoom to the *lowest* magnification to locate features more easily.

Note: Laser accuracy is independent of magnification level. The optics can be anywhere within the zoom range when using the laser.

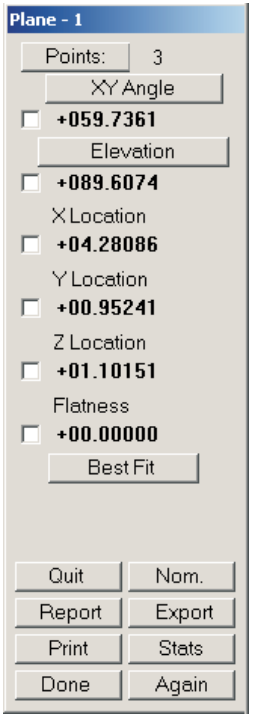
3. Click the **Laser Focus** icon or select **Laser** ⇒ **Focus** in the **Targets** menu to select the Laser Focus target.

4. Click the **Measure** tab and **Plane** icon or select **Plane** in the **Measure** menu.
5. Turn off the back light and turn on the surface illumination to approximately 45%.
6. Move the stage so that a surface near the lower-right hole is in the middle of the Image window and twist the Z axis fine adjustment knob on top of the joystick until the surface is in best focus.

WARNING: To prevent hazardous radiation exposure to your eyes, do not look directly at the laser beam while operating the laser.

7. Perform a laser focus on the surface and then press **Enter** on the joystick to accept the focus point.
8. Use the joystick to move the stage so that a surface near the lower-left hole is in the middle of the Image window.
9. Perform a laser focus, and then press **Enter** on the joystick to accept the point.
10. Move the stage so that a surface near the upper-left hole is in the middle of the Image window. Then repeat Step 9.

    The software displays the results of the plane measurement in the Measurement window.
11. In the Measurement window, click **Done** to complete the step.



Follow the steps below to practice using the linear laser scan function. In this tutorial, you will use the Laser Scan target to measure a contour on the surface of a penny.

1. Position a penny on the stage so that the Lincoln Memorial side of the penny is up and the memorial is parallel to the X axis.
2. Zoom to the *lowest* magnification to locate features more easily.

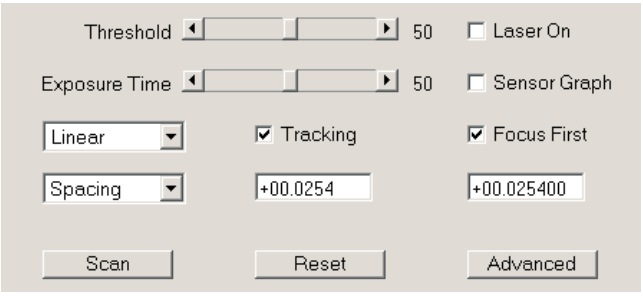
Note: Laser accuracy is independent of magnification level. The optics can be anywhere within the zoom range when using the laser.

---

3. Turn off the backlight and turn on the surface illumination to approximately 45%.

4. Click the **Laser Scan** icon or select **Laser** ⇒ **Scan** in the **Targets** menu to select the Laser Scan target.
5. Move the stage so that the left side of the Lincoln Memorial is in the middle of the Image window and make sure the image is in focus. If it is not, focus the image manually by rotating the Z axis fine adjustment knob on top of the joystick.
6. In the Laser Settings window:
   - Select **Linear** in the Scan Strategy list
   - Select **Spacing** in the Frequency list, and then type **0.0254** in the Point Spacing box
   - Select the **Tracking** and **Focus First** check boxes

Note: Typically, you want both Tracking and Focus First turned on before starting a scan, so that the software performs an autofocus at the start of the scan and attempts to keep the feature centered within the capture range of the laser throughout the scan.



7. In the **Measure** menu, select **Contour**.

8 Click next to the left end of the Lincoln Memorial to specify the start point of the laser scan (see below).

9. Move the stage so that the right side of the Lincoln Memorial is in the middle of the Image window and click next to the right end to specify the end point of the laser scan (see below).

The software displays the following information at the bottom of the Image window:

- the approximate time it will take for the scan to be completed (T)
- the number of points that the laser is expected to scan (P)
- the number of points selected to initiate the scan

WARNING: To prevent hazardous radiation exposure to your eyes, do not look directly at the laser beam while operating the laser.

10. In the Laser Settings window, click **Scan** to begin the laser scan.

    The system moves the laser to the optics location, turns off the video illumination and performs the scan.

Note: The blue Laser Indicator LED on the front cover flashes as the laser takes height measurements.

Note: You can stop the scan at any time by pressing the **Stop/Start** button.

The system displays the results of the contour measurement in the Measurement window when the scan is finished.

11. Compare the number of expected points with the actual number of points in the step. If the values differ by more than 10%, determine the reason for the difference, e.g., significant Z height variations, and evaluate whether the scan should be repeated with different parameters.

Note: If you want to repeat the scan with different parameters, simply change the desired settings and click **Scan** in the Laser Settings window.

12. In the Measurement window, click **Done** to complete the step.

Using the Box Scan Function to Create a Profile

Follow the steps below to practice using the Box scan function. In this tutorial, you will perform a Box scan to create a profile of the Lincoln Memorial on a penny.

Note: If you are performing this tutorial directly after the previous tutorial, *Using the Linear Scan Function to Measure a Contour*, skip Steps 1 through 4.

---

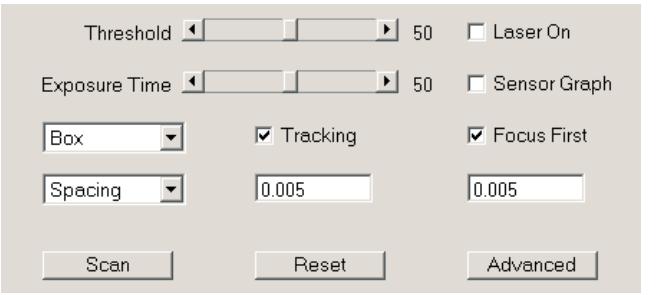
1. Position a penny on the stage so that the Lincoln Memorial side is up and the memorial is parallel to X axis.
2. Zoom to the *lowest* magnification to locate features more easily.

Note: Laser accuracy is independent of magnification level. The optics can be anywhere within the zoom range when using the laser.

---

3. Turn off the back light and turn on the surface illumination to approximately 45%.
4. Click the **Laser Scan** icon or select **Laser** ⇒ **Scan** in the **Targets** menu to activate the laser scan function.

5. Move the stage so that the left side of the penny is in the middle of the Image window and make sure the image is in focus. If it is not, focus the image manually by rotating the Z axis fine adjustment knob on top of the joystick.
6. In the Laser Settings window:

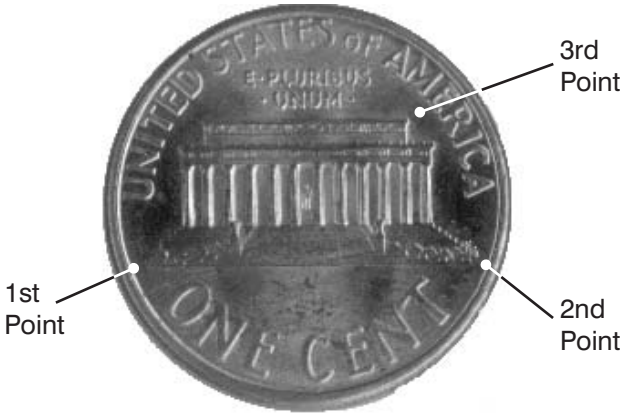


- Select **Box Scan** in the Scan Strategy list
- Select **Spacing** in the Frequency list, and then type **0.005** in the Point and Line boxes
- Select the **Tracking** check box
- Select the **Focus First** check box

Note: Typically, you want both Tracking and Focus First turned on before starting a scan so that the software performs an autofocus at the start of the scan and attempts to keep the feature centered within the laser's capture range throughout the scan.

---

7. In the Image window, click near the lower-left corner of the Lincoln Memorial (see below) to define the starting point of the scan.
8. Move the stage so that the right side of the penny is in the center of the Image window and click near the lower-right corner of the Lincoln Memorial (see below) to define the end point of the first linear scan and the orientation of the box scan length.
9. Click near the upper-right corner of the Lincoln Memorial (see below) to define the location of the last linear scan and the width of the box scan.



The software displays the following at the bottom of the Image window:

- the approximate time it will take for the scan to be completed (T)
- the number of points that the laser is expected to scan (P)
- the number of points selected to initiate the scan

WARNING: To prevent hazardous radiation exposure to your eyes, do not look directly at the laser beam while operating the laser.

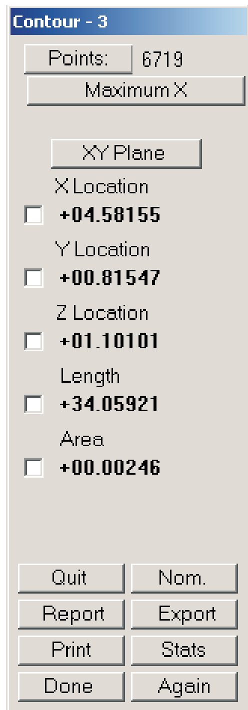
10. In the Laser Settings window, click **Scan** to begin the laser scan. The system moves the laser to the optics location, turns off the video illumination, displays the Surface window, and scans the feature.

Note: The blue Laser Indicator LED on the front cover flashes as the laser takes height measurements.

The surface is constructed in the Surface window as the laser performs the scan. You can manipulate the surface using the icons in the Surface window toolbar or the mouse (see Section 4 for more information).

Note: You can stop the scan at any time by pressing the **Stop/Start** button.

When the scan is finished, the software displays the results of the Box scan in the Measurement window.

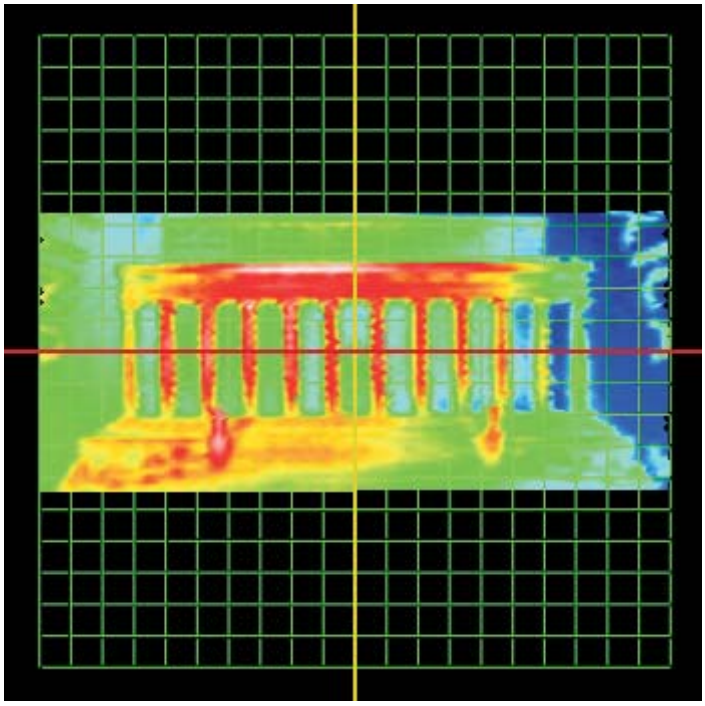


11. Compare the number of expected points with the actual number of points included in the step. If the values differ by more 10%, determine the reason for the difference, e.g., significant Z height variations, and evaluate whether the scan should be repeated with different parameters.

Note: If you want to repeat the scan with different parameters, simply change the desired settings and click **Scan** in the Laser Settings window.

12. In the Measurement window, click **Done** to complete the step.
13. In the **View** menu, select **Model** ⇒ **Display**, and then select the profile you just created.
14. Click the **Surface Window** icon to view the surface.

    You should see something similar to the following:



Note: You can manipulate the surface using the icons in the Surface Window toolbar or the mouse (see Section 4 for more information).

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Appendix C

Unexpected Contact

The information presented in this appendix only applies to systems equipped with a retractable laser slide assembly.

On systems equipped with a retractable laser slide assembly, the DRS laser is held in position by spring loaded posts. If the sensor bumps an obstacle while the stage is in motion, it may get knocked out of position as shown in Figure C-1

Figure C-1. DRS Laser (out of position)

To clear the laser sensor E-stop condition follow the steps below.

WARNING: Failure to place the system into E-stop could result in personal injury.

1. Press the **Stop/Start** button on the joystick to place the system into E-Stop.
   - If the laser is resting on the obstruction, go to Step 2.
   - If the laser is not resting on the obstruction, go to Step 4.
2. Lift the Z axis slide so that it is not resting on the obstruction.
3. Move the stage along the X and/or Y axis to remove the obstacle from the laser area.

4. Re-align the laser sensor by rotating until it snaps back into its correct position, shown in Figure C-2.

Note: The laser mount is spring loaded, which makes it easy to realize when you have reached the correct sensor mount position. It will snap into position.

Figure C-2. DRS Laser (correct position)

5. Press the **Stop/Start** button on the joystick.

WARNING: This returns power to the system. To avoid personal injury, do not place hands or body near the stage or optics.

6. Use the joystick to drive the Z axis slide.
    - If the system does not return to normal operation, then the Z axis slide may have disengaged from the lead screw. Contact the OGP Service Department at (585) 544-0450 for information about resolving this E-Stop condition.

Appendix D

Troubleshooting

This appendix is a guide to troubleshooting errors that you may encounter when using the DRS laser. If the solutions do not correct your problem(s), contact your local authorized OGP Service Representative or the OGP Service Department at (585) 544-0450.

Problem	Corrective Action(s)
The Scan laser control button is greyed out	• Make sure that a laser scan strategy (Linear, Circular, or Box) is selected; the scan button is disabled when the Focus strategy is selected. • Make sure you have selected the minimum number of definition points for the selected scan strategy, e.g., three points for a circular scan. • Make sure that the expected number of points to be included in the scan does not exceed 99,999. If necessary, adjust the point and/or line frequency values, or reduce the dimensions of the laser scan.
Sensor gives inaccurate data	• Turn on the Sensor Graph and observe whether multiple peaks appear above the threshold bar. If necessary, increase the Threshold parameter. • Check the sensor lens. If dirt collects on the front lens, clean the lens. • Perform the rough and fine laser alignment procedures described in Section 2.
You experience data drop-outs when performing a laser scan	• Decrease the point and/or line frequency settings. • Increase the Maximum Exposure parameter. • Decrease the Speed parameter. • See also *Unable to Obtain Readings*

Problem	Corrective Action(s)
You cannot accurately position the part because the laser spot is not visible	• Click in the Laser On check box in the Advanced Laser Settings window to more clearly view the laser spot while positioning the part.
Unable to obtain readings	• Focus the sensor to make sure the sensor has sufficient signal strength.

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