VIEW Engineering, Inc.

Benchmark™ 450
Service Manual

VIEW Engineering, Inc.
A Quality Vision International Company

VIEW Engineering, Inc.

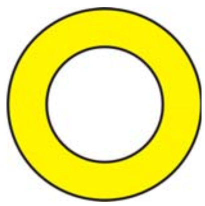
Benchmark™ 450
Service Manual

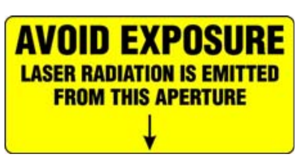
Part No. 799014, Revision B, 09/09

Benchmark equipment is made in the U.S.A.

Table of Contents

Important System Labels

Label:	Location:	Definition:
	Around the remote E-Stop Around the E-Stop on the front of the machine	(Yellow ring around red switch) Emergency stop
	Left and right sides of the Z-axis cover	Pinch hazard
	Rear panel of the electronics enclosure, lower-left corner	Dangerous voltage present; disconnect power before servicing to avoid electrical shock
	Right side of the electronics enclosure, above the power cord receptacle	Fuse label
	Lower-left corner of Main System ID label	System meets the requirements of the European Union (EU)

Label:	Location:	Definition:
	Front surface of the base, upper-right corner	System model and serial number
	Rear panel of the electronics enclosure, lower-left corner	Main system ID
	Right side of the laser (if equipped)	International laser symbol
	Right side of the laser (if equipped)	Indicates that the laser meets Class 2 requirements of the IEC-825 European standard
	Right side of the laser (if equipped)	Indicates that the laser meets Class II requirements of the CFR 21 standard
	Right side of the laser (if equipped)	Identifies the laser emitting aperture

About This Manual

Chapter 1

1.1 What This Chapter Contains

This chapter covers the following:

- Who Should Read This Manual
- Required Knowledge
- What's in This Manual?
- Where to Read More
- Where to Get Help

1.2 Who Should Read This Manual

Read this manual if you will perform any of the following tasks on the Benchmark 450 system:

- Installation
- Preventive maintenance
- Troubleshooting
- Service adjustments
- Parts replacement

For information on programming and configuring, refer to the *VMS Fast Start Guide* (P/N 790438) and *VMS Reference Guide* (P/N 790411).

1.3 Required Knowledge

To use this manual, you should be familiar with:

- How to maintain and service inspection or industrial automation equipment
- How to use and troubleshoot a computer
- Basic electrical and mechanical terminology and inspection equipment terminology

Note: We recommend that the procedures described in this manual be performed by trained and authorized personnel.

1.4 What's in This Manual?

Chapter	Title	Contents
2	General Description	Defines what the Benchmark 450 system is and familiarizes you with the basic hardware components.
3	Safety Information	Describes the remote Emergency Stop switch and covers other safety issues.
4	Installation	Describes how to: • Choose an installation site. • Unpack, move and install the Benchmark 450 system. • Power up the system, verify the system, and shut down the system.
5	Principles of Operation & System Interconnections	Describes subsystems and the interconnections within the Benchmark 450 system.
6	Preventive Maintenance	Lists actions you should take to keep the Benchmark 450 system in good operating order.
7	Troubleshooting	Helps you identify the cause of possible problems with the Benchmark 450 system, the system computer, and the user components.
8	Service Adjustments	Describes how to calibrate and align the system optics.

Chapter	Title	Contents
9	Parts Repair & Replacement	Describes how to replace imaging, transport, and electrical components.
A	VMS System Certification & Verification 7.02	Describes how to certify and verify the system.
B	TTL Laser Calibration	Describes how to calibrate the optional TTL laser.
C	Accessing VMS Parameters	Describes how to access VMS parameters.
D	Software Installation	Describes how to install the VMS software and Elements software.

1.5 Where to Read More

For information about using the Benchmark 450 system, refer to the software manual(s), software release notes, and OEM manuals that shipped with your system.

1.6 Where to Get Help

If you are faced with a situation you cannot resolve using this manual, contact the Customer Support HelpDesk, at:

VIEW Engineering, Inc.
1650 N. Voyager Avenue
Simi Valley, CA 93063, USA

Phone:	805-578-5000 Toll free: 877-SOS-VIEW (877-767-8439)
Fax:	805-578-5092
E-mail:	viewsupport@vieweng.com
Website:	www.vieweng.com

Be ready to provide the following information when contacting us:

- Model and serial number of your system
- Nature of the problem
- Steps you have taken
- Your phone and fax numbers
- Case number if you are calling about an issue that has already been reported

General Description

Chapter 2

2.1 What This Chapter Contains

This chapter covers the following:

- What is the Benchmark 450 System?
- Benchmark 450 System Main Components
- Coaxial Light, Programmable Ring Light, & Backlight
- Dual Magnification Optical System
- Computer & User-Interface Components

2.2 What is the Benchmark 450 System?

The Benchmark 450 system is a non-contact, three-dimensional measurement system with a full range of vision-based measurement tools and software. It has 450 mm x 450 mm x 150 mm (18" x 18" x 6") XYZ travel.

The system has precision dual magnification optics, coaxial and backlight illumination, and autofocus circuitry for high-accuracy Z-axis measurements over a variety of surface textures, finishes, and colors. The LED Programmable Ring Light (PRL) is optional.

No upgrades are necessary to achieve full automatic inspection.

Note: See the *VIEW Benchmark 450 Technical Data Sheet* (part number 799003) for more technical information.

2.3 Benchmark 450 System Main Components

The Benchmark 450 system is a large travel, floor standing machine. The X-axis travels on an overhead bridge above the worktable. Parts are measured by mounting them on the worktable, which moves in the Y direction. The system has an integrated workstation for the flat-panel display, 3-axis joystick, keyboard, mouse, and remote E-Stop switch. The system computer is located on the shelf attached to the right side of the machine.

There are two Emergency Stops: one is located on the workstation, within easy reach of the operator, and the other is on the base of the machine.

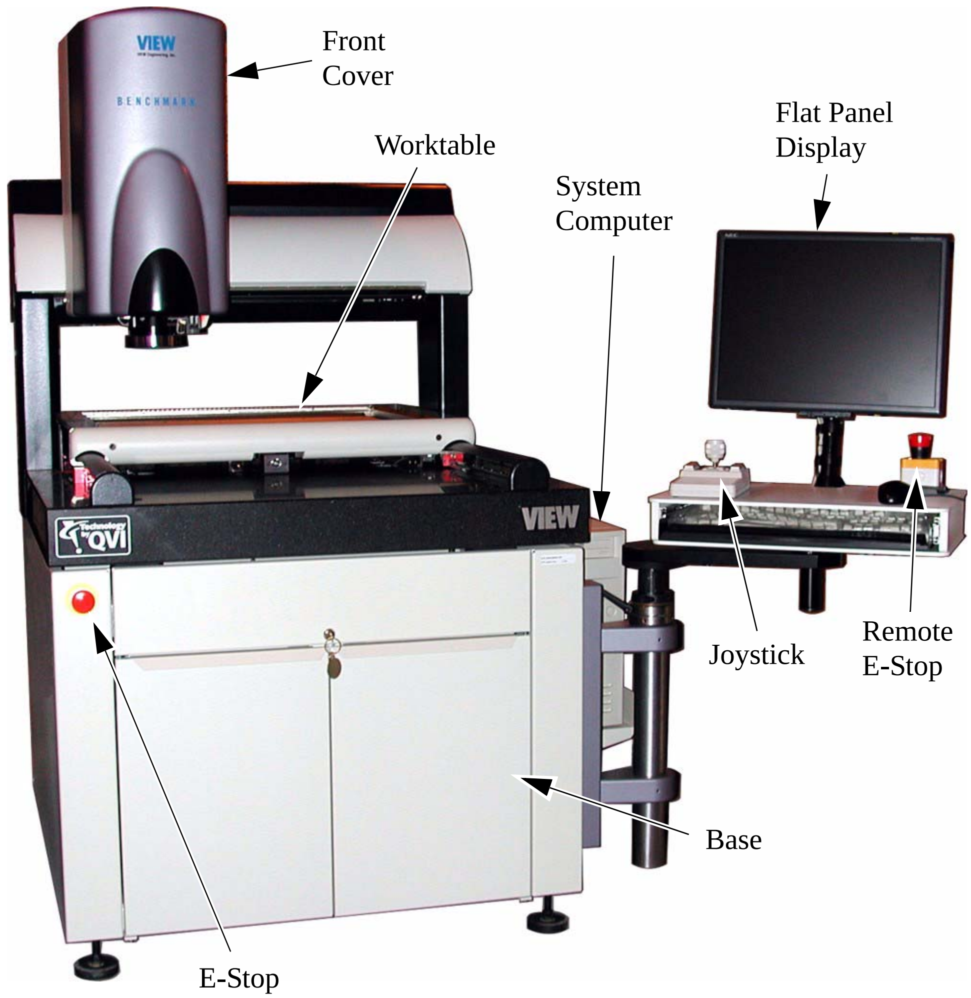


Figure 2-1 Benchmark 450 System Main Components

2.4 Coaxial Light, Programmable Ring Light, & Backlight

The LED coaxial light, LED Programmable Ring Light (PRL), and LED backlight assemblies are used to illuminate the part on the worktable.

The following table describes each feature:

Feature	Description
LED Coaxial light (through the lens)	Projects the light straight down through the magnification lens — it is also used in conjunction with the Ronchi grid (the Ronchi grid is used to focus on very flat, non-textured parts)
LED Programmable Ring Light (PRL)	Allows you to control illumination via four quadrants at various angles
LED Backlight	Projects the light upward through the stage glass, from below the part under inspection

2.5 Dual Magnification Optical System

The dual magnification optical system uses two monochrome cameras on two separate optical paths to provide instant magnification switching under software control. A third optical path is included to provide coaxial (through the lens) illumination and grid pattern for autofocus.

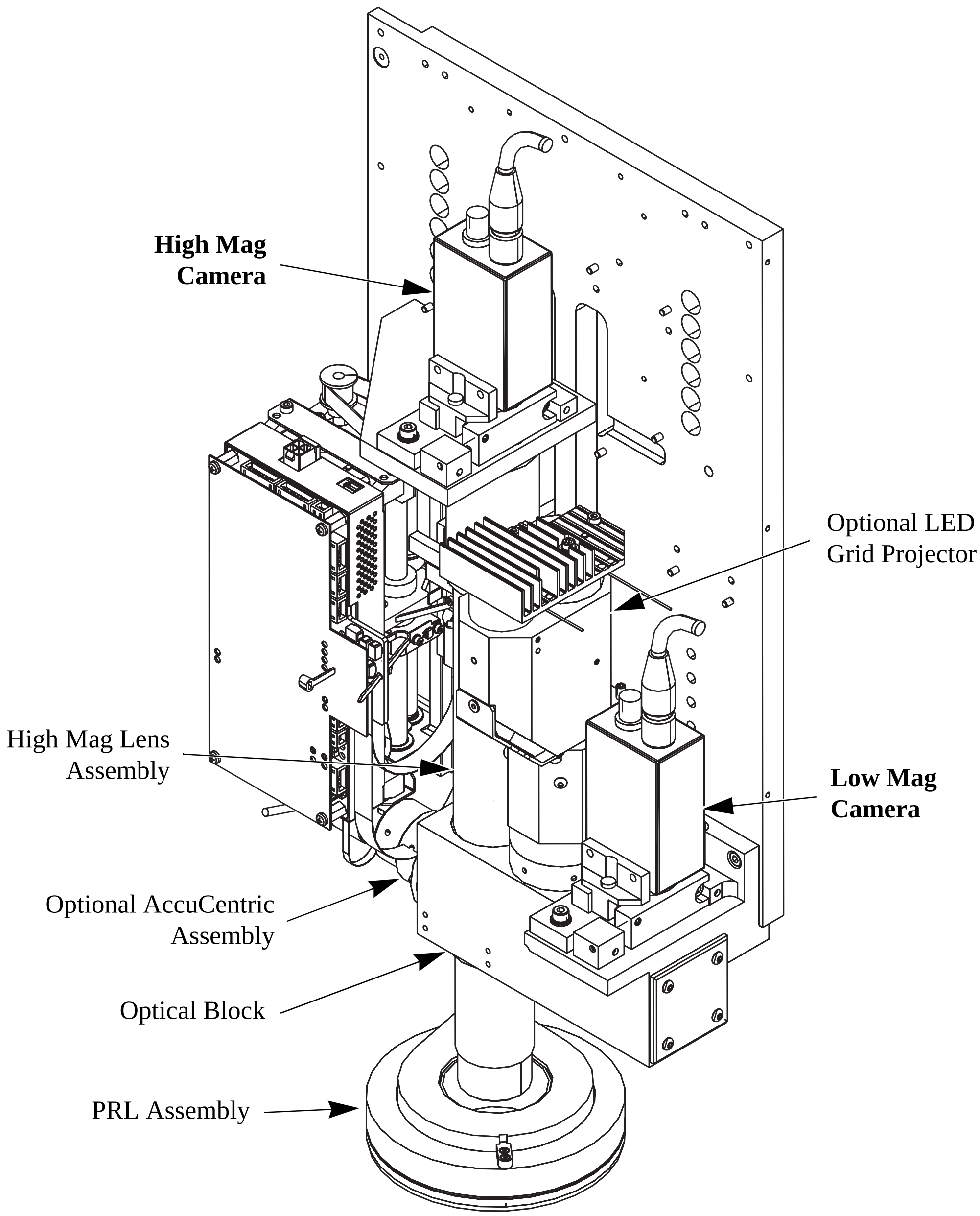


Figure 2-2 Optical Components (shown with optional LED grid projector)

2.6 Computer & User-Interface Components

The Benchmark 450 system operates on an Intel-based computer. The system comes with a joystick, mouse, keyboard and flat-panel display, and runs theVMS metrology software on the Windows XP (or 2000) operating system.

The following is a summary of additional information you should know about the user-interface components provided as part of the Benchmark 450 system.

2.6.1 Mouse

Unless specified otherwise, the left mouse button is used for most actions. The right mouse button is used for special actions (for example, to display a context menu in a specific window).

2.6.2 Keyboard

- F1 is usually reserved for Help; press it to display the Help menu.
- Tab will move the mouse cursor from one field to another in a dialog box.
- If the mouse cursor is in the Features window, you can press the left mouse button and [Ctrl] to drive the stages to the location where the mouse cursor is in the Feature window.

2.6.3 Joystick

Use the joystick to move the:

- Optical assembly in the X direction
- Worktable in the Y direction
- Optical assembly in the Z direction

To move	You must
the optical assembly along the X-axis	move the joystick lever left and right (east and west)
the worktable along the Y-axis	move the joystick lever forward and backward (north and south)
the optical assembly along the Z-axis	twist the joystick knob clockwise (to raise the optics) and counterclockwise (to lower the optics)

This page has been left intentionally blank.

Safety Information

Chapter 3

3.1 What This Chapter Contains

This chapter covers the following:

- Emergency Stops
- System Power
- System Lockout
- Safety Guidelines

Also, be sure to review the information about important system labels on page vii.

3.2 Emergency Stops

Activate the emergency off (EMO) circuit by pressing the remote E-Stop on the workstation (see Figure 3-1) or the E-Stop on the front of the machine.

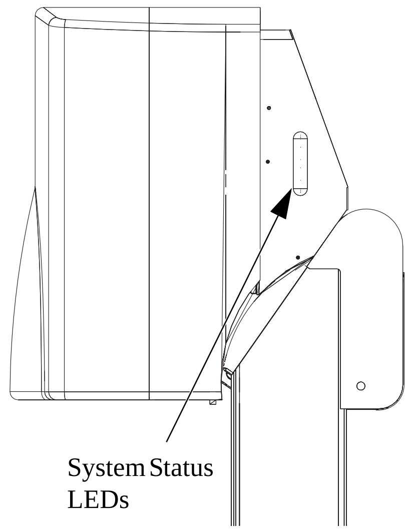
Figure 3-1 Remote E-Stop

The EMO circuit is responsible for disabling system motion in case of an emergency. The EMO circuit places the system in a safe (shutdown) condition, which cuts power to the motors.

3.3 System Status LEDs

The system status LEDs are located on the right-hand side of the Z-axis cover.

- The top LED is (yellow) is the Stop LED
- The middle LED (green) is the Power On LED
- The bottom LED (blue) is the Laser Indicator LED (only present is if system is equipped with a laser).



The following table includes information regarding the status of the Stop LED and provides instructions for recovering from different Stop conditions.

Stop LED Status	Description	Cause	How to Recover
Off	System is in normal operation	—	—
On	Recoverable stop	Occurs during the normal power-up sequence until the Stop/Start button on the joystick is pressed	When prompted, press the **Stop/Start** button on the joystick.
		Occurs when the X, Y, or Z transport encounters an end-of-travel limit	Move the transport off the limit, and then press the **Stop/Start** button on the joystick
		Occurs when servo parameter settings are incorrect	Check LED DS7 on the DSP Multi Axis PCBA for the source of the E-Stop (see ***Diagnostic LED DS7 E-Stop Codes*** on page 70).
		Occurs when the remote E-Stop is pressed	Reset the remote E-Stop switch by twisting the knob in the direction of the arrows, and then press the **Stop/Start** button on the joystick.

3.4 System Power

The system comes with an IEC power strip (P/N 037545) and three identical power cords (P/N 019978) that connect the monitor, system computer, and machine to the power strip. An external power cord connects the power strip to the external power source (outlet). External power cord characteristics vary depending on the country of installation, as outlined in the table below.

Warning: Always use the IEC power strip and the external power cords provided with the system. Use of an inappropriate power connection could lead to equipment damage and/or electrical shock.

Country	Power	Part Number	Type	AWG (US)	Wire Cross Section (CE)
United States	120 VAC, 50/60 Hz	019938	3-Conductor	18	0.82 mm^2
Japan	100 VAC, 50 Hz	019938	3-Conductor	18	0.82 mm^2
United Kingdom	240 VAC, 50 HZ	019971	3-Conductor	18	1.00 mm^2
Italy	220 VAC, 50 HZ	019972	3-Conductor	18	1.00 mm^2
Denmark	220 VAC, 50 HZ	019974	3-Conductor	18	1.00 mm^2
Switzerland	220 VAC, 50 HZ	019975	3-Conductor	18	1.00 mm^2
Other European Countries	220 VAC, 50 HZ	019973	3-Conductor	18	1.00 mm^2

3.5 System Lockout

Before servicing the system, you must unplug the power cord and lock out the system. This will protect you and others from unintended machine operation, which could result in personal injury. No one should attempt to defeat a lockout while the machine is being serviced.

Most companies have a safety department and written procedures for locking out the system. These procedures typically have the following features as a minimum:

- Each operator, supervisor, and maintenance person who may be required to work on the machine shall have a key operable lock.
- If more than one key exists for the lock, the owner of the lock shall have possession of all of the keys.
- Each lock shall be labeled with the owner’s name, or the owner shall be supplied with an identity tag that may be attached to the lock when it is applied to the machine.

To lock out the system:

1. Close all programs and shut down Windows.

2. Power down the monitor.

3. Press the remote E-Stop.

4. Unplug the main power cord from the power source and lock the plug into an appropriate energy isolating device.

5. Perform the required service and/or maintenance.

Note: Each person performing maintenance or making adjustments to the system should have their own lock attached to the energy isolating device. There are commercially available multi-lock devices to allow this.

To resume normal operation:

1. After determining it is safe, have each person remove his or her own lock.

2. When all locks are removed, reconnect the power cord to the main power source.

3. Reset the remote E-Stop by twisting the knob in the direction of the arrows.

4. Power up the system and resume normal operation.

3.6 Safety Guidelines

For your personal safety, observe the following safety precautions and guidelines. They are provided for your protection and to help prevent damage to the system.

General Precautions:

- The system is intended to be used by personnel who recognize the hazards associated with electrical shock and computer-controlled mechanical motion.
- The system is intended to be used for metrology applications only; other use may void your warranty.
- To prevent the accidental pinching of your hands, do not approach or touch the machine during operation.
- To avoid personal injury, never attempt to manually move the Z-axis slide with power applied to the machine.
- To avoid personal injury, always mount the part(s) you are measuring or inspecting in a fixture that is secured to the worktable.
- Always power down and lock out the system before servicing it.

Power and Grounding:

- Ensure that the source of power connected to the system does not apply more than the rated voltage (specified by VIEW Engineering, Inc.) between the supply conductors or between either supply conductor and ground.
- The system is grounded through the power cord. To avoid electrical shock, connect the power cord to a properly wired receptacle with an earth ground connection.
- Connect the system to a dedicated circuit.

Power Cord:

- Only use the power cord and connector specified for the system.
- Do not operate the system if the power cord is damaged.
- Position the power cord so it will not be a trip hazard, or come in contact with a hot surface.

Miscellaneous:

- To avoid a fire hazard, only use fuses that meet all type, voltage, and current requirements specified by VIEW Engineering, Inc.
- Do not operate the system without all covers and panels installed properly.
- Keep water and other liquids away from the system to reduce the risk of spillage and electrical shock.
- Do not use any accessory attachments other than those provided or approved by VIEW Engineering, Inc. Improper accessories can cause fire, electrical shock, and/or personal injury.
- Do not drop anything on the stage glass.

Unsafe Operating Environments:

- Do not operate the system in hospitals, clinics, or laboratories where sensitive patient monitoring equipment may be affected.
- Do not operate the system in a radioactive environment because the electronics in the machine are not radiation-hardened.
- Do not operate the system in environments where flammable gases and vapors or explosive dust are present. These could be ignited by the heat or sparks that may be generated by the system.

Installation

Chapter 4

4.1 What This Chapter Contains

This chapter covers the following:

- Choosing an Installation Site
- Benchmark 450 System Layout
- Receiving, Unpacking, & Inspecting the System
- Moving & Installing the System
- Connecting the System
- Powering Up the System & Launching the VMS Software
- Operation Checks
- Post Installation Checklist
- Shutting Down the System
- Installing the X, Y, & Z Shipping Restraints
- Fixture Mounting Holes

4.2 Choosing an Installation Site

Before installing the system, choose a site that meets the following criteria:

Specification	Requirement:
Temperature	Recommended operating range: 17° to 33°C Rated environment: 18° to 22°C
Humidity	30% to 80% non-condensing Condensation can cause corrosion
Vibration	<0.0015g below 15Hz In order to maintain system accuracy, do not locate the system near to production equipment susceptible to vibration (for example: stamping presses, mills, or lathes).
Weight	Crated: 750 kg (1,650 lbs) Uncrated: 610 kg (1,345 lbs)
Electrical Requirements	115/230 VAC, 50/60 Hz, 700 W
Dimensions (W x D x H)	Machine: 99.8 x 142.5 x 176.6 cm (39.3" x 56.1" x 69.6") w/Computer Shelf: 131.7 x 142.5 x 176.6 cm (51.9" x 56.1" x 69.6") w/Integrated Workstation: 174.8 x 142.5 x 176.6 cm (68.6" x 56.1" x 69.6") Make sure there is adequate space for an operator to spread out materials and use the system comfortably.
Service access	Allow 61 cm (24") clearance around the machine for cables and service access.

The Benchmark 450 system does not require air, steam, or exhaust. Vacuum and/or air may be required for special fixtures only.

4.3 Benchmark 450 System Layout

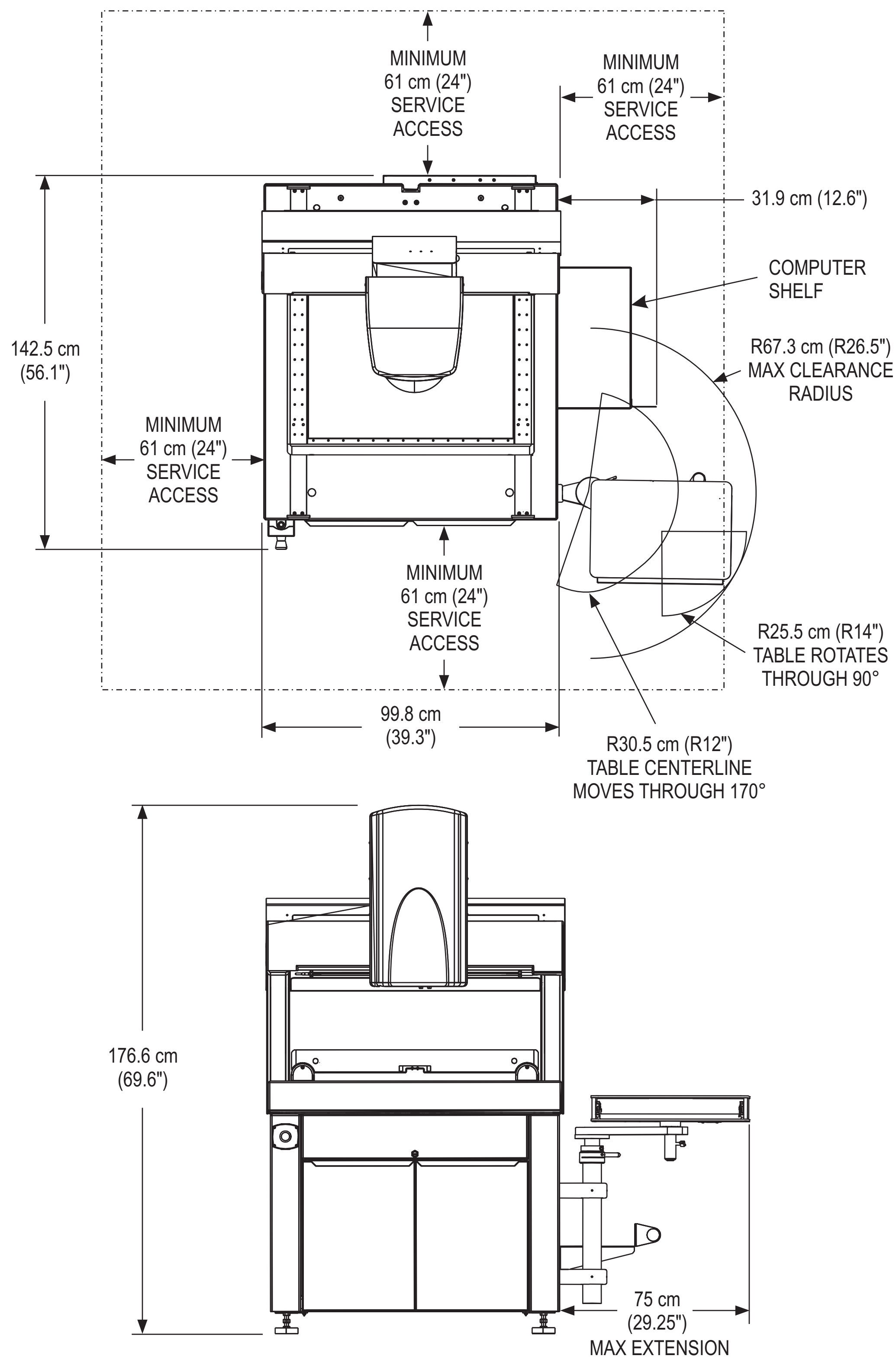


Figure 4-1 Benchmark 450 System Layout

4.4 Receiving, Unpacking, & Inspecting the System

When you receive the system, the shipment will include a pallet that contains the machine, computer equipment, and any optional accessories.

Note: The following procedure provides general unpacking instructions. See the *Benchmark 450 Installation Manual* (P/N 799034) for detailed instructions.

Note: Before unpacking the machine, be sure to review the table at the beginning of this section for information about equipment dimensions, space requirements, workbench requirements, and environmental considerations.

Tools Required
Forklift — capable of lifting 900 kg (2,000 lbs)
Large diagonal cutters
Phillips-head screwdriver
3/4-inch or adjustable crescent wrench

1. Inspect the shipping crate for damage.

Note the condition of the shipping crate. If any damage is found, STOP! Contact the Customer Support HelpDesk (see ***Where to Get Help*** on page 4).

2. Disassemble the crate and remove the external packing material.

3. Remove the stage glass and all accessory boxes from the pallet. Set everything aside.

4. Unlock (with the supplied key) and open the front doors on the base.

5. Remove the shipping bolts that secure the machine to the pallet.

4.5 Moving & Installing the System

Note: The following procedure provides general installation instructions. See the *Benchmark 450 Installation Manual* (P/N 799034) for detailed instructions.

1. Drive a forklift to the back of the machine and position the forks under the support rails on the bottom of the machine.
2. Slowly lift the machine straight up off the pallet.
3. Remove the support blocks and pallet. Store them for future use.
4. Set the height of each machine support to 7.5 cm (3") and move the machine to the final operating location.
5. Slowly lower the machine onto the floor, so it is resting on all four machine supports.
6. Set a bubble level on the worktable to determine if the machine is level in the X and Y directions. If the machine is not level in both directions, lift the machine, re-adjust the height of the machine supports, and slowly lower the machine. Repeat as many times as necessary until the top surface of the worktable is level in the X and Y directions.
7. Remove any remaining packing material.
8. Unpack the remaining system components and place them in their respective areas on the user workstation.
9. Remove the X, Y, and Z shipping restraints.
10. Unpack and install the stage glass.
11. Connect the system components.

4.6 Connecting the System

Figure 4-2 illustrates Benchmark 450 system cabling and the table on the next page provides further detail. All cables are clearly labeled regarding function and where each end connects.

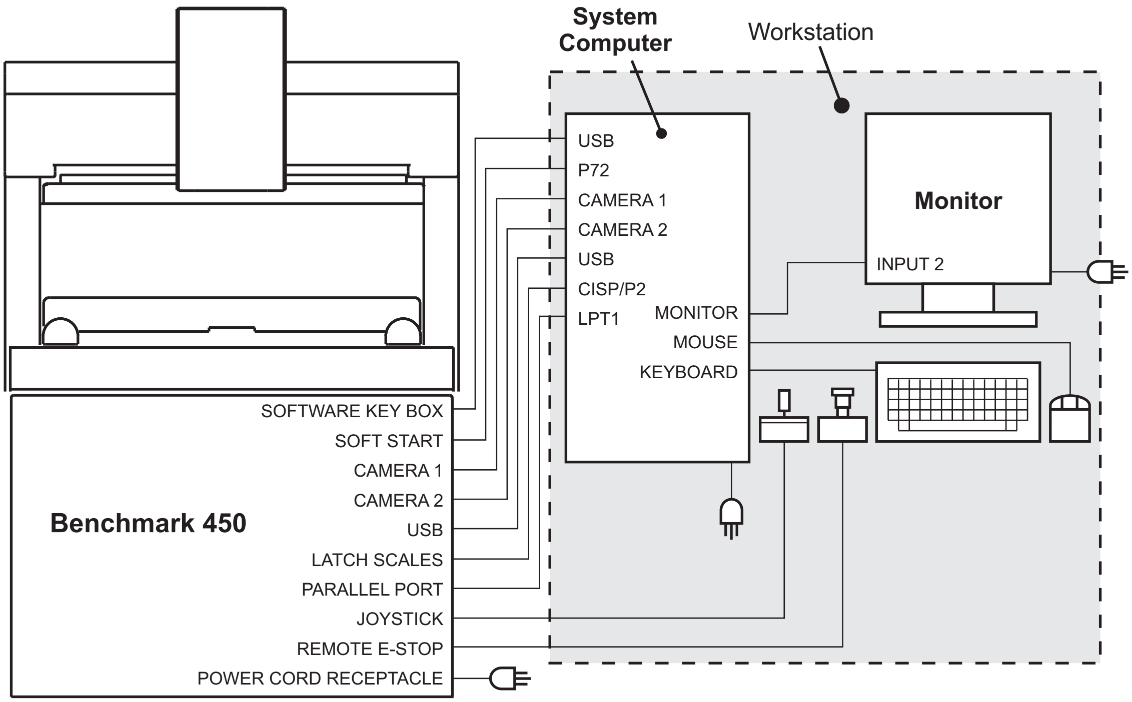


Figure 4-2 Benchmark 450 System Cabling Diagram

Connect the…	to the…	and the…
Joystick (P/N 039037)	**JOYSTICK** connector on the machine	—
Remote E-Stop (P/N 039836)	**REMOTE E-STOP** connector on the machine	—
Keyboard (P/N 036821)	Purple keyboard connector on the system computer	—
Mouse (P/N 035136)	Green mouse connector on the system computer	—
Monitor cable	**INPUT 2** connector on the monitor	**MONITOR** connector on the system computer
Soft Start Extension cable (P/N 049012.08)	**SOFT START** connector on the machine	**P72** connector on the system computer
Camera 1 cable (P/N 060155-1)	**CAMERA 1** connector on the machine	**CAMERA 1** connector on the system computer
Camera 2 cable (P/N 060131.01)	**CAMERA 2** connector on the machine	**CAMERA 2** connector on the system computer
Parallel cable (P/N 036389)	**PARALLEL PORT** connector on the machine	**LPT1** connector on the system computer
Latch Scales cable (P/N 049022.19)	**LATCH SCALES** connector on the machine	**CISP/P2** connector on the system computer
USB cable (060158.04)	USB connector on the machine	USB connector on the system computer
Software Key Box (attached to the machine)	USB connector on the system computer	—
USB cable	USB connector on the monitor	USB connector on the system computer
Power cord (machine)	Machine	IEC power strip
Power cord (system computer)	System computer	IEC power strip
Power cord (monitor)	Monitor	IEC power strip
Power cord (IEC power strip)	IEC power strip	Appropriate power outlet

4.7 Powering Up the System & Launching the VMS Software

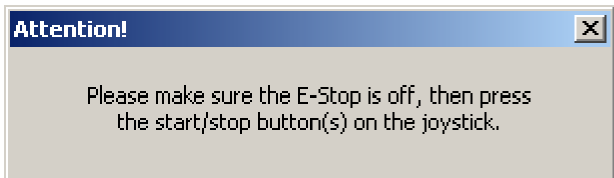
1. Make sure the system components are connected and the main power cord is plugged into an appropriate power source (outlet).

2. Power up the monitor, system computer, and any optional accessories.

3. Wait for the operating system to load.

4. Double-click the icon on the Windows Desktop.

   The following appears:



5. Verify that the E-Stops are not pressed in.

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

   The system initializes the stages, which may take a few minutes.

4.8 Operation Checks

After powering up the system and launching the metrology software, you should verify that it performs as expected. If the system fails any of the following operation checks, verify all connections are correct and secure. If the system still does not perform as described below, contact the Customer Support HelpDesk; (see ***Where to Get Help*** on page 4).

Caution: Before performing any of the following operation checks, verify that no parts, fixtures, or other obstructions are on the stage.

Action	Result
Press the remote E-Stop switch.	• The system enters E-Stop Mode — the yellow LED on the right side of the Z-axis cover illuminates. • A software message appears on the screen. • The X, Y, and Z transports do not move when you operate the joystick. To resume normal operation: 1. Clear the software message. 2. Reset the E-Stop by twisting the knob in the direction of the arrows. 3. Press the **Stop/Start** button on the joystick.
Move the joystick lever in any direction.	The X and Y transports move in the same direction.
Twist the joystick knob CW.	The Z transport moves up.
Twist the joystick knob CCW.	The Z transport moves down.
Press the **Stop/Start** button on the joystick.	• The system enters Stop Mode — the yellow LED on the right side of the Z-axis cover illuminates. • A software message appears on the screen. • The X, Y, and Z transports do not move when you operate the joystick. To resume normal operation: 1. Clear the software message. 2. Press the **Stop/Start** button on the joystick.

Action	Result
Adjust the illumination levels in the software.	The intensity of the selected illuminator should change as expected.

4.9 Post Installation Checklist

1. Focus Comparison

Adjust the Surface Focus and Ronchi Focus to a minimum difference when the system is installed for the first time or when the camera or optics are removed or adjusted; see ***Camera Parfocal Adjustment (Systems Equipped with Ronchi Grid)*** on page 130.

2. Lens Calibration

Create all related lens files by calibrating all magnification lenses; see ***Lens Calibration*** on page 141.

3. System Certification

Perform a full XYZ system certification and verification; see ***VMS System Certification & Verification 7.02*** on page 223. For more information, contact the Customer Support HelpDesk (see ***Where to Get Help*** on page 4).

4. System Backup

Backup all important operating files used by the Benchmark 450 system. All files are backed up via an option within the VMS software installation routine.

4.10 Shutting Down the System

Warning: The system must be shut down properly to prevent data loss.

Note: If Windows XP locks up and you cannot shut down the system as described below, press the remote E-Stop switch. Then press and hold the On/Off button on the system computer for approximately six seconds to shut down the computer and power down the system.

To exit the VMS software, do either of the following:

- Click the **X** in the top right corner of the VMS screen
- Select **File / Exit** in the VMS main menu

To shut down Windows XP and power down the system, do the following:

1. Close all programs.
2. Perform the standard Windows XP shutdown procedure.
3. Power down the monitor and any optional accessories.

4.11 Installing the X, Y, & Z Shipping Restraints

If you need to move the Benchmark 450 system, even a short distance, we recommend that you re-attach the shipping restraints to prevent the X, Y, and Z transports from moving. This reduces the chance of equipment damage.

Before powering down the system and installing the shipping restraints, position the transports as follows:

- Position the X transport to the left limit of its travel.
- Position the Y transport to the center limit of its travel.
- Position the Z transport so the bottom of the Z-axis slide is flush with the bottom of the Z-axis housing (see Figure 4-5 on page 31).

Caution: Do not attempt to move the XYZ transports with the shipping restraints installed.

The X-axis shipping restraint attaches to the X-axis rail, as shown in Figure 4-3 below. To install the X-axis shipping restraint, do the following:

1. Go to the back of the machine and use a Phillips-head screwdriver to open the rear bridge cover.

2. Attach the shipping restraint to the X-axis rail as shown in Figure 4-3. Use a 3/16-inch Allen wrench to tighten the socket-head screws that secure the shipping restraint to the X-axis rail.

3. Close the rear bridge cover and tighten the cover screws.

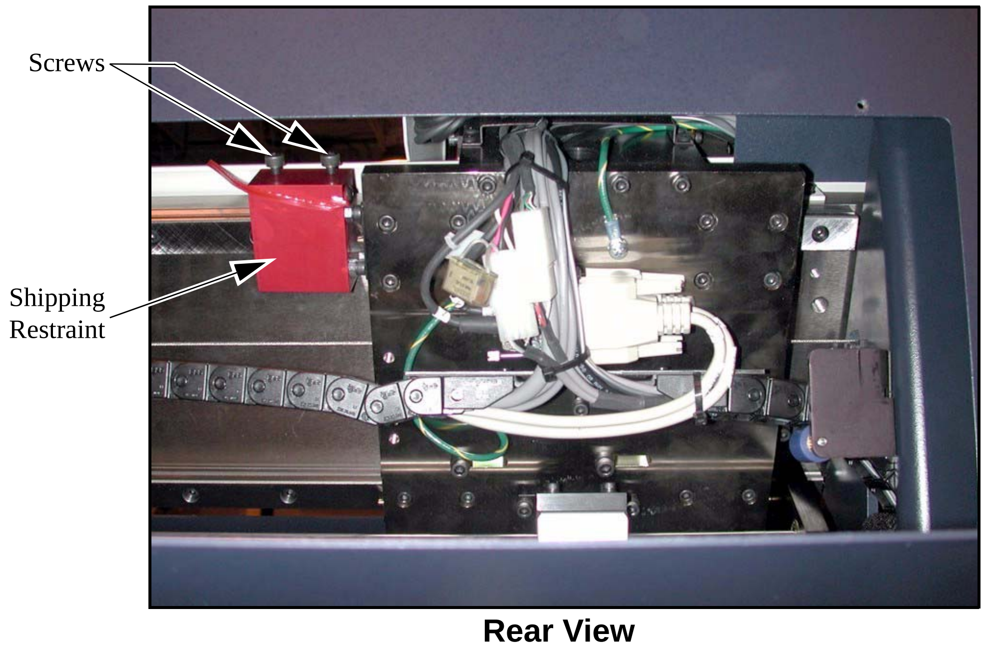


Figure 4-3 X-Axis Shipping Restraint

The Y-axis shipping restraint attaches to one of the Y-axis rails, as shown in Figure 4-4. To install the Y-axis shipping restraint, do the following:

1. Attach the shipping restraint to one of the Y-axis rails (see Figure 4-3), in front of the worktable.

2. Use a 3/16-inch Allen wrench to tighten the socket-head screws that secure the shipping restraint to the Y-axis rail.

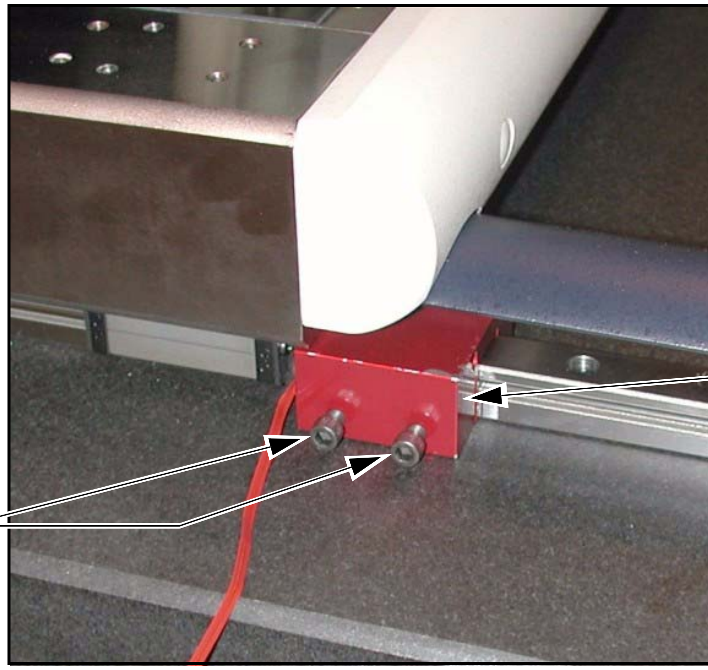


Figure 4-4 Y-Axis Shipping Restraint

Two Z-axis shipping restraints attach to the bottom of the Z-axis slide assembly, as shown in Figure 4-5. To install the Z-axis shipping restraints, do the following:

1. Use a 3 mm Allen wrench to remove the four Z-axis end stop screws.

2. Attach the two Z-axis shipping restraints to the bottom of the Z-axis slide assembly with the four Z-axis end stop screws (see Figure 4-5).

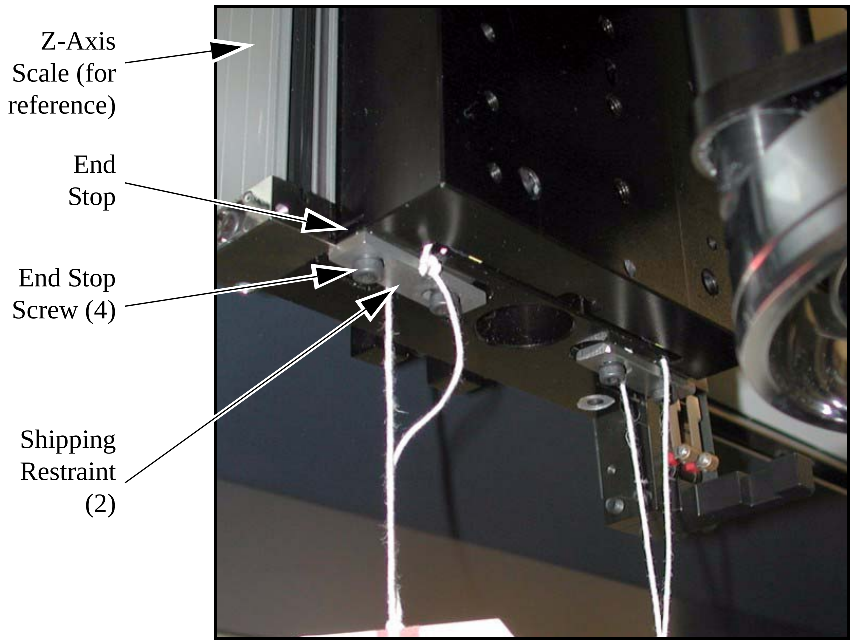


Figure 4-5 Z-Axis Shipping Restraints (2)

4.12 Fixture Mounting Holes

Use the M6 tapped holes along the each side of the worktable to mount fixtures to the worktable for securing and orientating parts. Any combination of holes can be used to attach a variety of fixtures.

Caution: Do not allow any objects to hang over the sides of the worktable while operating the machine. Doing so could result in equipment damage if the object makes contact with the fixed bridge supports.

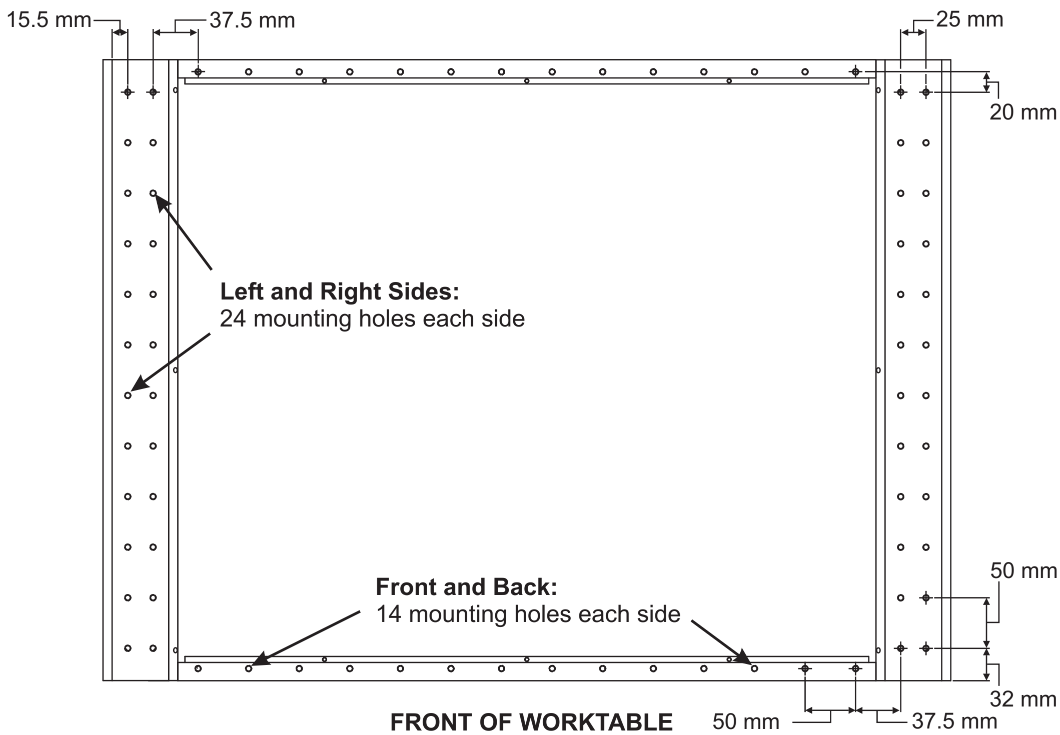


Figure 4-6 Benchmark 450 Fixturing Holes

Principles of Operation & System Interconnections

Chapter 5

5.1 What this Chapter Contains

This chapter covers the following:

- Overview of Operation
- Image Acquisition, Processing, & Display
- Motion Control
- Illumination Sources
- Zeroing the Stage
- Benchmark 450 Schematic Diagram

5.2 Overview of Operation

When a user creates a program to inspect a part, the resulting **part program** is a sequential list of instructions to the Benchmark 450 system.

The instructions include X, Y, and Z stage positions, lighting and their intensities, and tool parameters. The system drives the stages, sets the lights, and runs the tools according to the part program. Measurements are made using finders and image processing software within the system.

The software then looks at the next part program step and continues to each step until complete. During the execution of a program, calculations are made and the resulting data is either stored, printed, or sent to another type of I/O device.

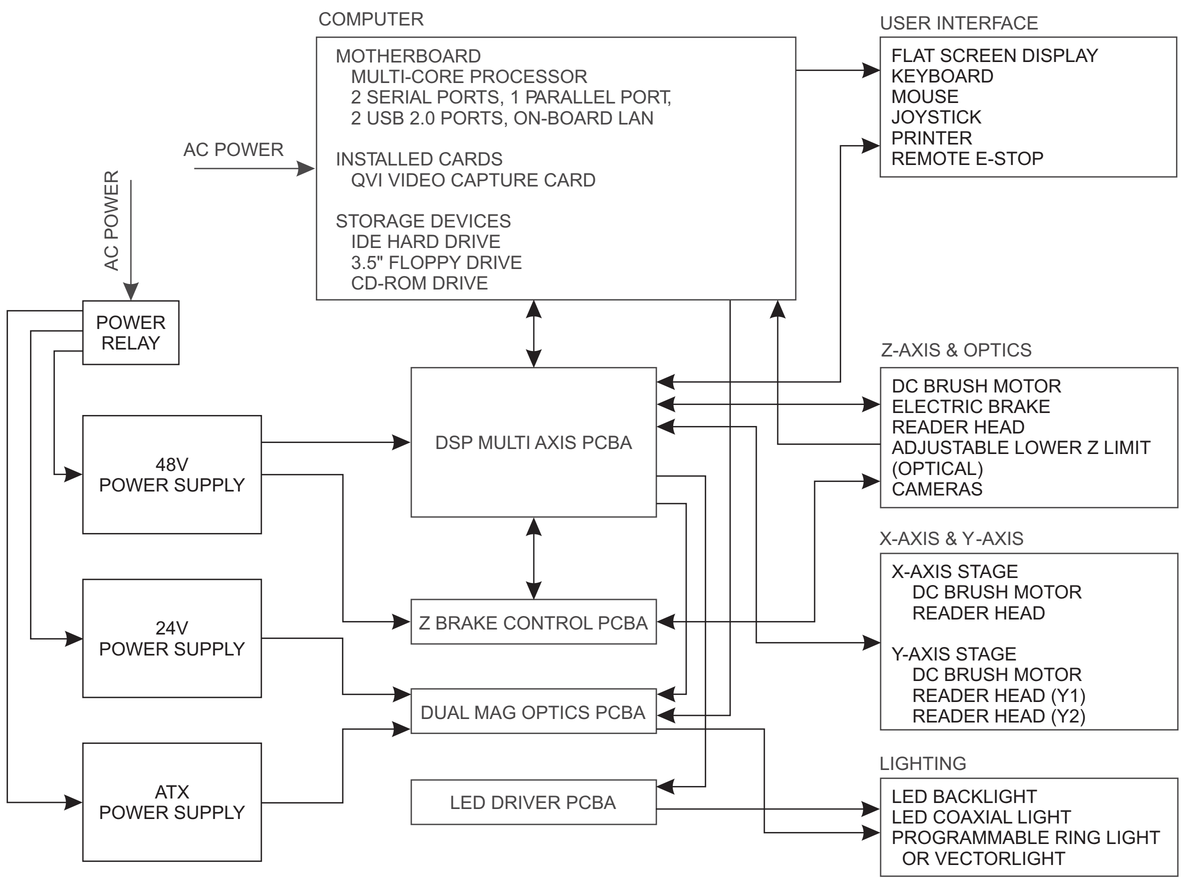


Figure 5-1 Benchmark 450 System Block Diagram

5.3 Image Acquisition, Processing, & Display

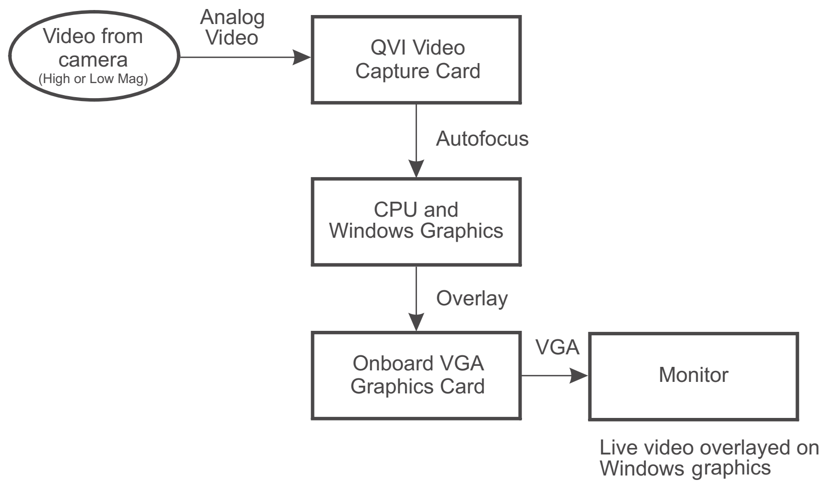


Figure 5-2 Image Acquisition

Note: The QVI video capture card is pre-installed in the system computer.

The following describes how the image acquisition, processing, and display components function in conjunction with other system elements to create images:

1. The High and Low Mag CCD video cameras provide real-time video to the system.
2. The video is routed to the QVI video capture card.
3. Windows graphics are overlayed onto the live video by the on-board VGA graphics card and sent to the attached monitor.

The QVI video capture card gets its video from the cameras. This video is used to control Z-axis focus processing and lighting.

The system is capable of performing two types of focus processing: Ronchi or Surface. Surface focus and Ronchi focus types are very similar and work almost the same way.

When performing a surface focus, an out-of-focus image will be more gray than an in-focus image. The sharper image will have better contrast. The video signal is converted to a digital number so the host CPU can monitor each value. During an autofocus, the CPU monitors these values and scale readings, and keeps the scale value for the highest contrast value incurred.

When performing a Ronchi focus, a projected grid is used and a band-pass filter of the same frequency as the projected grid is placed in the circuit. The more in focus the grid is, the higher the contrast value of the video.

5.4 Motion Control

This section describes the subsystems used in motion control and the motion control process.

5.4.1 X- & Y-Axis Motion

The X and Y motor assemblies and scale reader heads are mounted directly on the stages. The motor assemblies position the stage, and the feedback from each reader head (and scale) aid in positioning the stage and holding the actual position after it has been achieved.

The scales have a separate index flag mounted away from the reader heads to keep the stage coordinates the same each time the system is powered up and/or re-zeroed.

The scales and reader heads produce digital pulses every 0.5 micron (optional 0.1 micron scale is available). The pulses are used by the motion controller to determine stage position. The reader heads have LED indicators that are green when the reader head is properly aligned to the tape scale. Once properly aligned, no further adjustments to the signals are required.

There are magnetic limit switches at each end of stage travel. The limit switches allow the user to move the stages freely with the joystick without worrying about moving beyond the active measurement area of the system.

5.4.2 Z-Axis Motion

The Z-axis DC motor is mounted at the top of the Z-axis assembly and positions the Z-axis transport. Feedback from the reader head and glass scale aids in positioning the stage and holding the actual position after it has been achieved.

The glass scale and reader head produce digital pulses every 0.5 micron (optional 0.1 micron scale is available). The pulses are used by the motion controller to determine stage position.

The Z-axis motion system contains upper and lower magnetic limit switches and an adjustable lower optical limit switch. The adjustable lower limit can be set to limit the Z-axis travel in the down direction when required.

The electric brake assembly is mounted to the top of the Z-axis ball screw. While the system is in use, the brake is energized and the Z-axis transport is free to move. When power is removed from the brake, however, it activates and prevents Z-axis movement.

In addition to the electronic E-Stop devices, the Z-axis slide on the Benchmark 450 system is designed to separate mechanically ("break away") from the Z-axis drive if a physical obstruction prevents the transport from continuing its downward motion; the Z-axis drive bracket disengages from the drive nut, which causes the Z-axis slide to stop moving down even if the Z-axis drive continues to drive.

Warning: NEVER ATTEMPT TO MANUALLY MOVE THE Z-AXIS TRANSPORT BY TURNING THE BALL SCREW WITH POWER APPLIED TO THE MACHINE. Doing so could result in personal injury.

Warning: In the event of unexpected Z-axis contact, see ***Recovering from Unexpected Z-Axis Contact*** on page 114 for information about returning the system to normal operation.

5.5 Illumination Sources

The Benchmark 450 system has the following illumination (light) sources:

- [Standard] The **LED backlight** provides light from below the part, through the stage glass, to create a contour or profile shadow image of the part. The backlight should be aligned to be concentric with the camera optics.

- [Standard] The **LED coaxial illuminator** provides direct, “square on” light onto the surface of the part where it is reflected up into the optics. The assembly has a diffuser inside the housing where the LED is located that assists in distributing the light evenly across the field of view. The illuminator has a beam splitter, which is placed in the optical path.

- [Optional] The **programmable LED ring light** (PRL) has different color LEDs (red, green, and blue) and provides oblique top light. A cone of light projected onto the surface of the part creates a three-dimensional image that highlights heights, depths, and surface imperfections. The PRL can be positioned up or down on the lens tube depending on the illumination angle required.

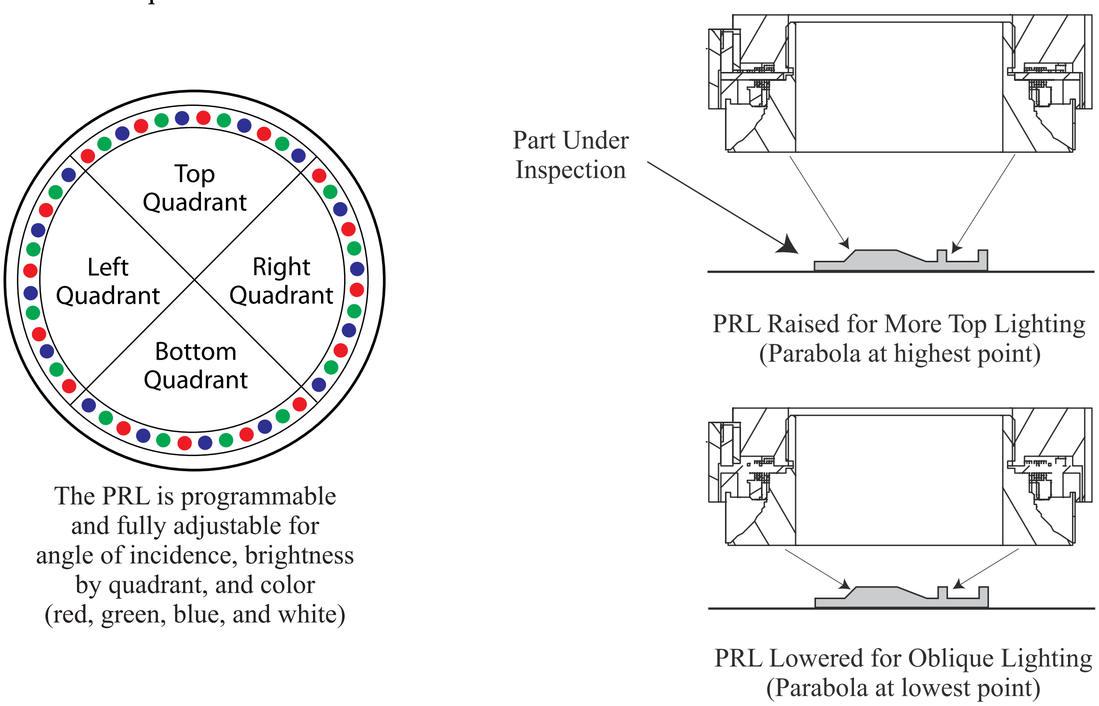


Figure 5-3 Video Path - PRL Optics

- [Optional] The **VectorLight** provides oblique surface illumination. The assembly consists of six concentric rings that can be split up into four quadrants. You can turn on/off individual rings or quadrants as well as adjust the intensity to effectively illuminate staged parts with varying incidence and directionality.

5.6 Optional LED Grid Projector

The optional LED grid projector mounts in place of the standard coaxial illuminator and adds the ability to project contrast onto surfaces that have little or no contrast, such as glass, when using high magnification. This allows you to perform an autofocus on such surfaces. Light passes through a grid pattern, and the pattern is projected onto the surface of the part under inspection.

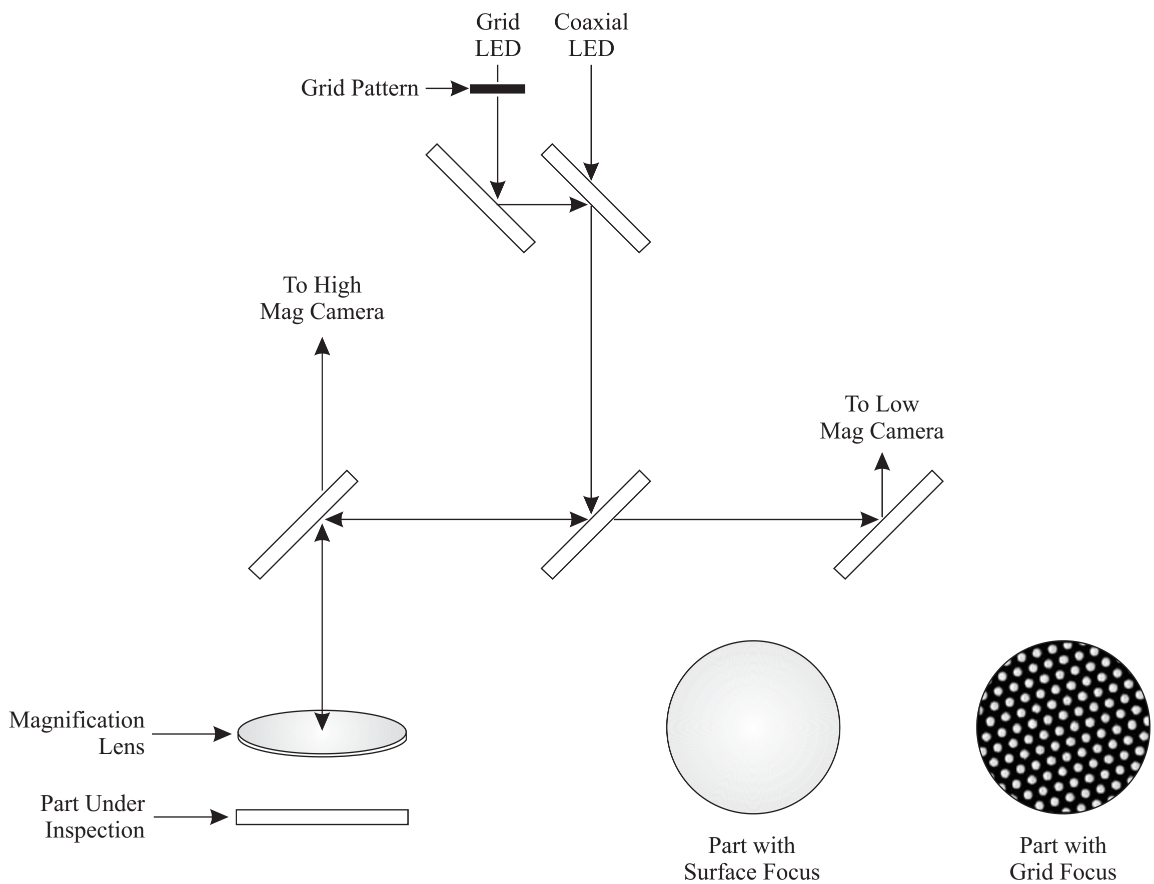


Figure 5-4 Video Path - LED Grid Projector

5.7 Optional Ronchi Shuttle Grid Assembly

The **Ronchi Shuttle grid assembly** consists of a motorized, three position shuttle and two chrome-on-glass reticles: one for High Mag and another for Low Mag. When Ronchi Focus is selected in the VMS software, the shuttle automatically moves the appropriate grid reticle into position under the coaxial illuminator. Light from the coaxial illuminator passes through the reticle, projecting a shadow onto the point of focus that creates artificial contrast where none may actually exist. The Ronchi focus is aligned to the video focal plane. When Surface Focus is selected, the shuttle moves to the center position (no grid). In this case, coaxial light passes through the opening in the shuttle and no shadow is projected onto the part under inspection.

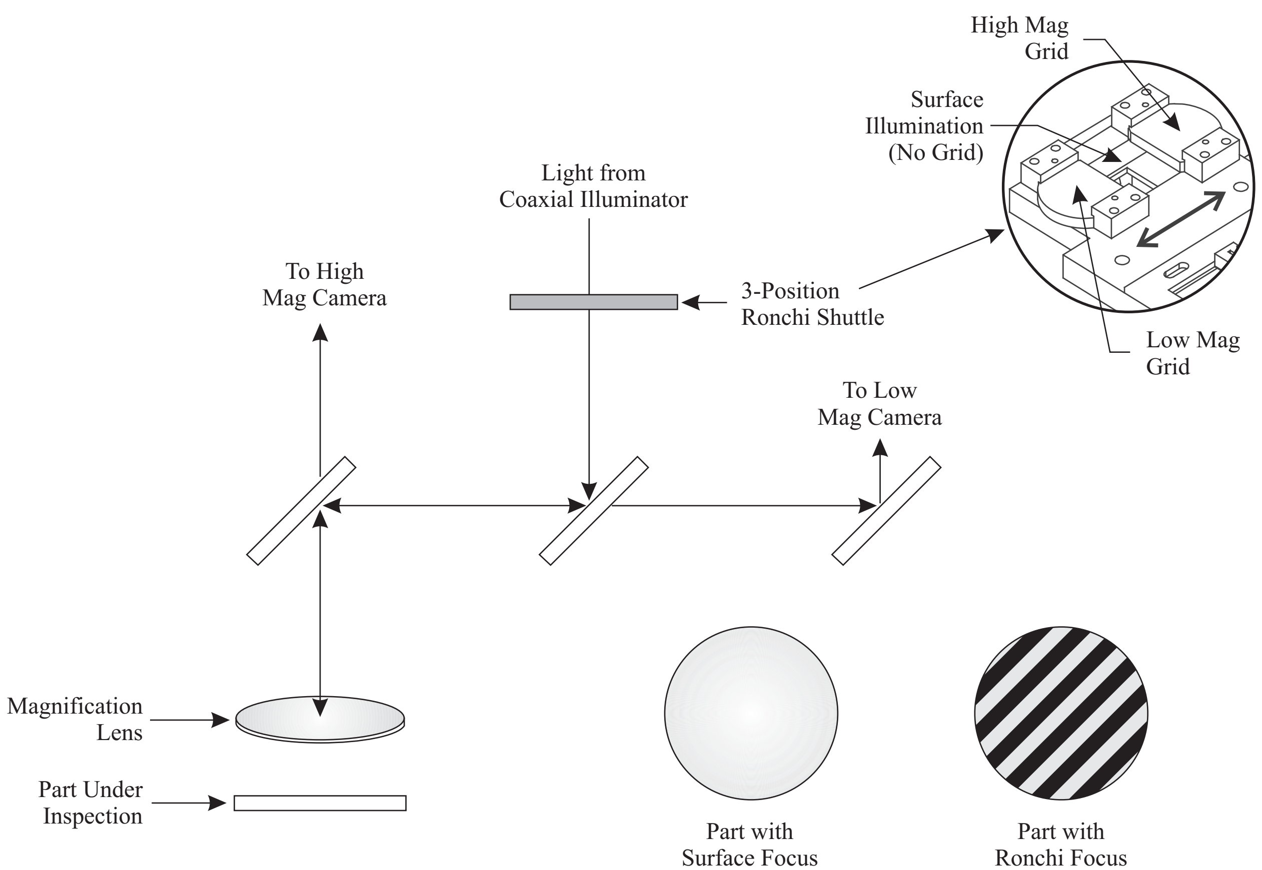


Figure 5-5 Video Path - Ronchi Shuttle Grid Optics

5.8 Optional AccuCentric Assembly

The **AccuCentric assembly** inserts a reticle image into the optical path. This image is used to re-calibrate the optical system whenever you switch from High Mag to Low Mag, and vice-versa. As you switch magnification, the image is remeasured to automatically calibrate the position of the optical axis.

5.9 Zeroing the Stage

When the stage is zeroed, each axis is driven to one side until the magnetic limit switch is triggered. The stage then reverses direction and finds the index pulse. At this index pulse the stage counter is set to zero. The stage is then set to the same location each time the system is reset or powered up.

5.10 Benchmark 450 Schematic Diagram

Note: A copy of the latest revision of the system interconnect is available for every machine. If there are any discrepancies between this manual and the Benchmark 450 system interconnect (P/N 031799), always refer to the system interconnect.

This page has been left intentionally blank.

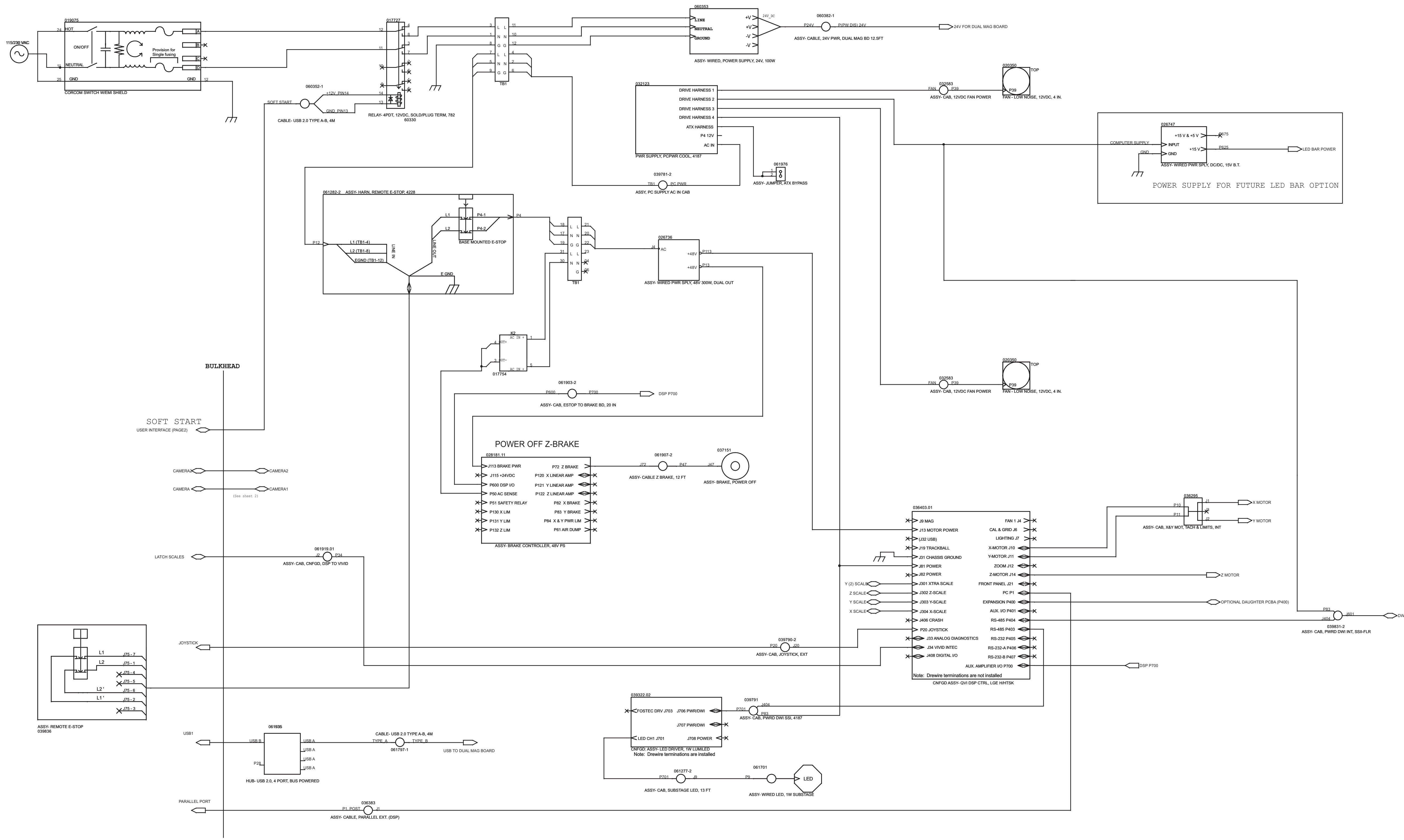


Figure 5-11 Overall System Interconnect (Sheet 1 of 2)

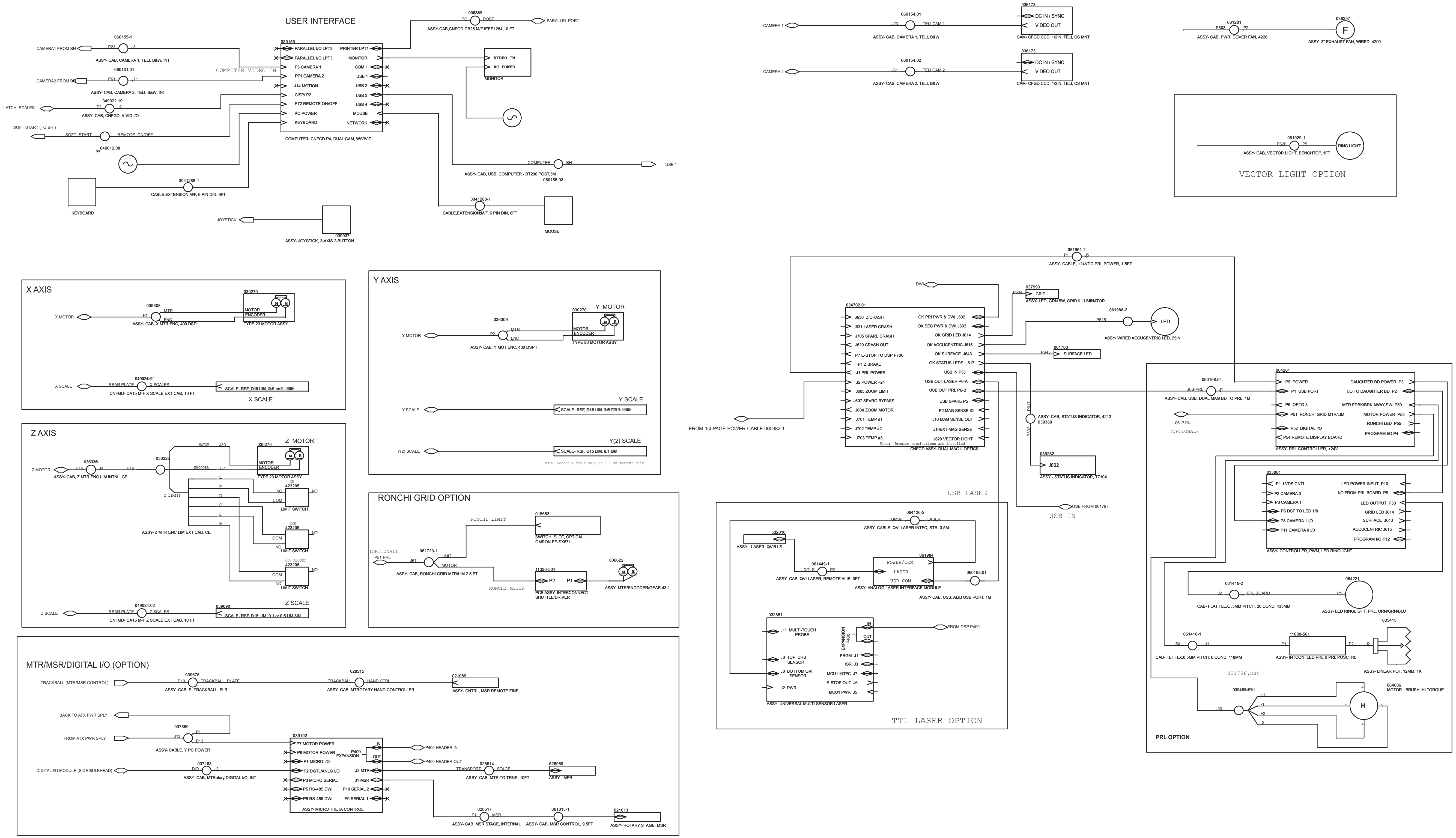


Figure 12 Overall System Interconnect (Sheet 2 of 2)

Preventive Maintenance

Chapter 6

6.1 What This Chapter Contains

This chapter covers the following:

- Preventive Maintenance Schedule
- Cleaning the User Components
- Cleaning the Stage, External Surfaces, & Stage Glass
- Cleaning & Lubricating the X-Axis and Y-Axis Rails
- Cleaning the Magnification Lens
- Cleaning the LED Programmable Ring Light (PRL)
- Checking for Dirt in the Images of the Video Cameras
- Verifying Proper System Operation

Warning: Unless instructed otherwise, always power down the system and disconnect the power cord from the main power source while performing preventive maintenance; see ***System Power*** on page 13.

Warning: The risk of electrical shock is present anytime the covers are removed from the machine. To avoid exposure to high voltage, never remove the covers from the flat-panel display or system power supplies.

6.2 Preventive Maintenance Schedule

Below is a summary of the Benchmark 450 preventive maintenance tasks and their recommended frequencies.

Note: You may need to perform the preventive maintenance tasks more or less frequently, depending on the environment in which the system is used. For example, some tasks may need to be performed more often if the system is located in a harsh environment. Contact the Customer Support HelpDesk (see ***Where to Get Help*** on page 4) for specific recommendations.

Caution: Failure to perform preventive maintenance tasks may void your warranty and additional support services may result in charges for those services.

Preventive Maintenance Task	Frequency	Where to Find Procedure
Clean the user components	Every six months	See ***Cleaning the User Components*** on page 47.
Clean the stage, external surfaces of the machine, and stage glass	Every six months	See ***Cleaning the Stage, External Surfaces, & Stage Glass*** on page 48.
Clean and lubricate the X-axis and Y-axis rails	Every six months	See ***Cleaning & Lubricating the X-Axis and Y-Axis Rails*** on page 56.
Clean the magnification lens	As needed	See ***Cleaning the Magnification Lens*** on page 61.
Clean the programmable ring light (PRL)	As needed	See ***Cleaning the LED Programmable Ring Light (PRL)*** on page 63.
Check for dirt in the images of the video cameras	As needed	See ***Checking for Dirt in the Images of the Video Cameras*** on page 64.
Verify proper system operation	As needed	See ***Verifying Proper System Operation*** on page 64.

6.3 Cleaning the User Components

Materials Required
Soft, lint-free toweling
Pure, compressed air
Alcohol-based cleaner
Non-solvent glass cleaner
Vacuum cleaner
Swabs

Caution: Never connect or unplug the mouse or keyboard from the PS2 port on the system computer while the system is energized. Doing so could damage the motherboard in the system computer.

6.3.1 Cleaning the Joystick

Use swabs moistened with alcohol or a water-based cleaner to remove buildup from the point where the stick enters the housing.

6.3.2 Cleaning the Mouse

Shut down the computer and unplug the mouse. Then use alcohol or a water-based cleaner to remove the buildup from the bottom of the mouse. Remove and clean the ball if needed.

6.3.3 Cleaning the Flat Panel Display

Vacuum the vent slots to remove any dust that may have accumulated. Clean the screen with a non-solvent glass cleaner and soft, lint-free toweling.

6.3.4 Cleaning the Keyboard

Shut down the computer and unplug the keyboard. Then use compressed air to remove any dust from between the keys. If necessary, use swabs moistened with alcohol.

6.4 Cleaning the Stage, External Surfaces, & Stage Glass

Materials Required
Soft, lint-free cloth
Pure, compressed air
Alcohol-based cleaning solution
Warm water mixed with a mild detergent or commercial surface cleaner
Commercial glass cleaner

6.4.1 Cleaning the Stage

Caution: Do not use water to clean the stage.

Wipe all external surfaces of the stage with an alcohol-dampened, lint-free cloth. Then wipe dry with a clean, dry, lint-free cloth. Use pure, compressed air to clean the fixturing holes in the stage.

6.4.2 Cleaning External Surfaces

Warning: Do not allow cleaning solution to get into the machine while cleaning it. This can cause internal damage to the machine and can cause electrical shorts and/or fires with the subsequent risk of personal injury. Always apply the cleaning solution to the cloth; do not apply the cleaning solution directly to the machine.

Caution: Do not use paint thinners to clean the external surfaces of the machine.

Clean the external surfaces of the machine with warm water and a mild detergent or with a commercial surface cleaner.

6.4.3 Cleaning the Stage Glass

Note: Typically, it is only necessary to clean the top surface of the stage glass. Unless it is absolutely necessary to clean the underside of the glass, do not remove the stage glass from the stage. The stage glass may require re-leveling if removed.

To clean the stage glass without removing it (top surface only), follow the steps below.

1. Use the joystick to drive the Y-axis transport to the front limit of travel.
2. Power down the system and disconnect the power cord from the power source.

Caution: Do not spray the stage glass with cleaner while it is mounted within the stage.

3. Spray a soft, lint-free towel with a commercial glass cleaner and wipe the top surface of the stage glass until it is clean.

To remove the stage glass and clean both sides, follow the steps below.

1. With the system powered up, use the joystick to drive the Y-axis transport to the front limit of travel.
2. Power down the system and disconnect the power cord from the power source.
3. Use a 2 mm Allen wrench to **loosen** (do not remove) the three set screws in the back of the worktable.
4. Reach under the front of the stage and push up on the stage glass. Carefully lift the stage glass off the stage and remove it.
5. Gently set the stage glass down and clean both sides with glass cleaner and soft, lint-free toweling.
6. When ready, carefully set the back edge of the stage glass onto the back recessed ledge in the stage opening. Then reach under the front of the stage to support the stage glass as you slowly lower it into position.
7. Make sure the glass is centered within the stage and tighten (do not overtighten) the set screws in the back of the stage.
8. Level the stage glass as described next.

6.4.4 Leveling the Stage Glass

1. Power up the system.
2. Attach four pieces of masking tape (or similar tape) to the stage glass in the approximate locations shown in Figure 6-1.

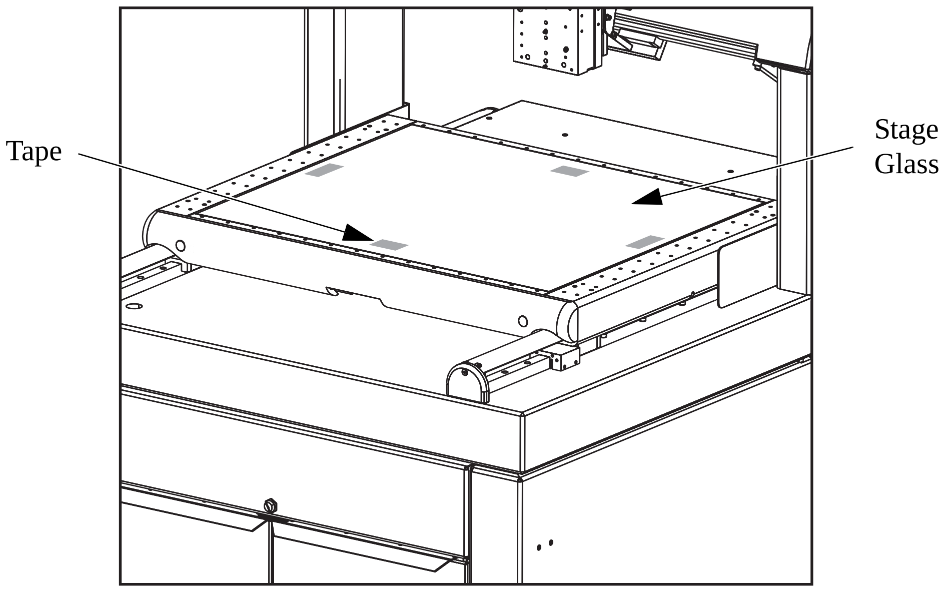


Figure 6-1 Tape Locations on the Stage Glass

3. Determine whether or not the stage glass is level in the X direction by doing the following:

   a. Drive the stages so an edge of the tape on the left side of the stage glass appears in the center of the Video window.

   b. Use the Autofocus Finder to focus on the edge of tape at high magnification.

   c. Zero the DRO and drive the stages so an edge of the tape on the right side of the stage glass appears in the center of the Video window.

   d. Use the Autofocus Finder to focus on the edge of tape at high magnification. Look at the Z-axis readout, which should be as close to zero as possible.

      – If the reading is within **±0.08 mm (±0.003")**, the stage glass is level in the X direction.

      – If the reading is not within specification, the stage glass needs to be leveled.

4. Repeat Step 3 to determine whether or not the stage glass is level in the Y direction, using the pieces of tape on the front and back of the stage glass. Again, look at the Z-axis readout, which should be as close to zero as possible.

   - If the reading is within **±0.08 mm (±0.003")**, the stage glass is level in the Y direction.
   - If the reading is not within specification, the stage glass needs to be leveled.

If the stage glass needs to be leveled in the X and/or Y directions, continue with the rest of this procedure. Otherwise, stop here.

5. Drive the Y-axis stage to the front limit of travel.

6. Power down the system and disconnect the power cord from the power source.

7. Remove the stage glass and carefully set it aside.

8. Use a 5 mm Allen wrench and a 3 mm Allen wrench to remove the front stage cover and both Y-axis rail covers (see Figure 6-2).

9. Use a 2.5 mm Allen wrench to remove the underlight tray cover.

10. Re-install the stage glass. Make sure the stage glass is centered within the stage.

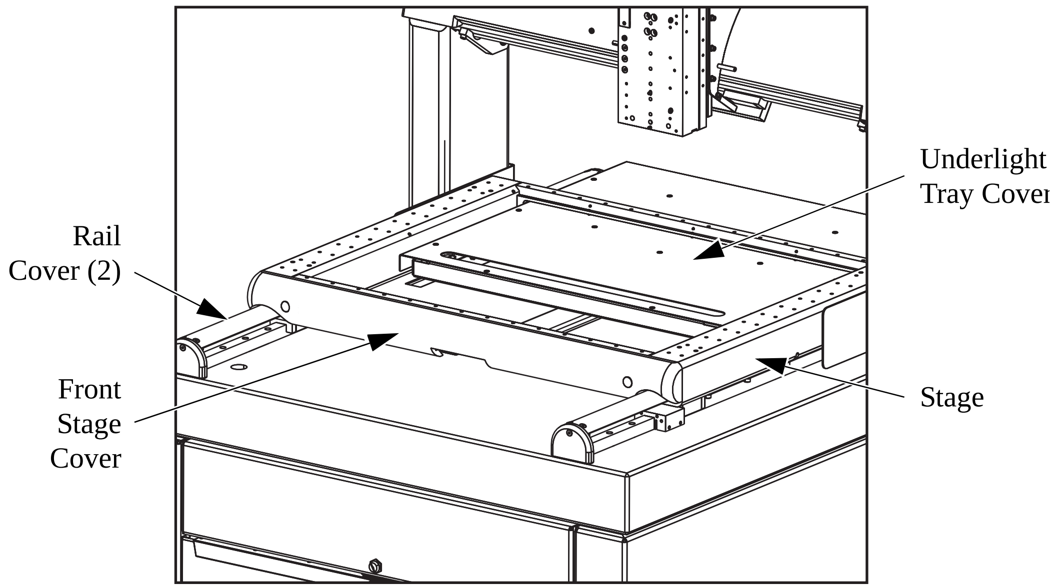


Figure 6-2 Removing the Front Stage Cover, Y-Axis Rail Covers, and Underlight Tray Cover

---

Note: In order to access the stage glass leveling screws, you must remove the front stage cover, both Y-axis rail covers, and the underlight tray cover.

---

11. Attach a bracket with a straight bottom edge to each corner of the stage. Then place 0.010" shim stock between each bracket and the stage glass (see Figure 6-3).

Note: Using 0.010" shim stock ensures that the top surface of the stage glass is below the top surface of the stage.

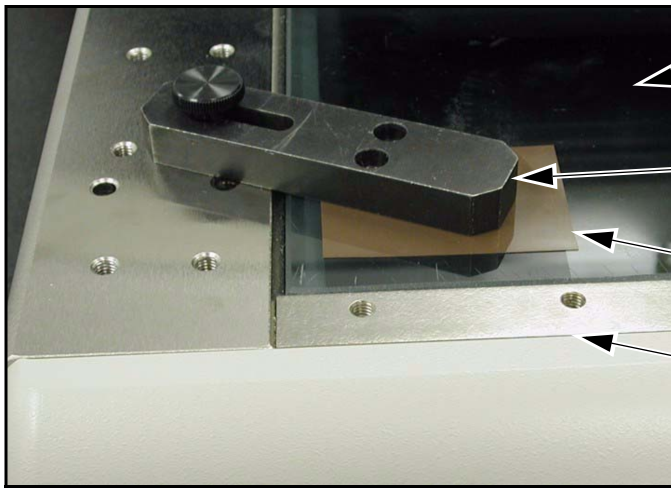


Figure 6-3 Bracket Attached to the Stage

12. Use a 3 mm Allen wrench to **loosen** the six nylon-tipped stage glass support screws (accessed from below the stage); see Figure 6-4. Use the access holes on the sides of the stage to access the two middle screws.

13. Use a 2 mm Allen wrench to adjust the six leveling screws (accessed from below the stage) as necessary to position the stage glass the correct distance below the top surface of the stage.

14. Tighten the six support screws so they just touch the stage glass. Do not overtighten the screws, which could affect the leveling of the glass.

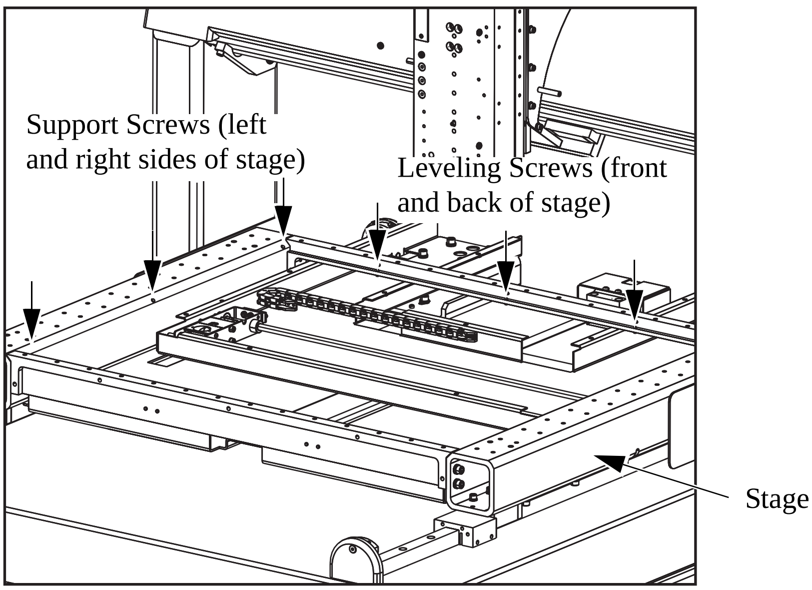


Figure 6-4 Location of Stage Glass Leveling Screws

15. Remove the four brackets and shim stock.

16. Power up the system and perform Steps 1 through 4 to verify that the stage glass is level in both the X and Y directions. If necessary, repeat Steps 11 through 15 to re-level the glass.

17. Repeat Step 16 as many times as necessary to level the stage glass.

Caution: When re-installing the underlight tray cover, be careful not to remove the rubber washers glued to the underlight tray.

18. Carefully remove the stage glass and re-install the underlight tray cover.

19. Re-install the stage glass (make sure it is centered within the stage).

20. Perform Steps 1 through 4 to verify that the stage glass is still level in both the X and Y directions.

- If the stage glass is level, shut down the system and disconnect the power cord from the main power source. Then tighten (do not overtighten) the set screws in the back of the stage.
- If the stage is not level, repeat Steps 11 through 19 to level the glass.

21. Re-install the front stage cover and both Y-axis rail covers.

22. Remove the tape from the stage glass.

6.5 Cleaning & Lubricating the X-Axis and Y-Axis Rails

Note: It is important to clean the X-axis and Y-axis rails periodically to remove contaminants and grease buildup. It is also important to apply the proper amount of lubricant; **do not over-lubricate**.

Lubricating the X-axis and Y-axis rails consists of two tasks:

- Clean the rails
- Apply the lubricant in the prescribed manner

Materials Required

Phillips-head screwdriver (for the X-axis)
Grease gun (NSK HGP) and fitting nozzle (NSK HGP NZ4)
NSK PS2 lubricant (NSK GRS PS2)
Soft, lint-free toweling

6.5.1 Cleaning & Lubricating the X-Axis Rails

1. Use the joystick to drive the X-axis transport to the approximate center of its travel.

2. Power down the system and disconnect the power cord from the power source.

3. Use a Phillips-head screwdriver to open the rear bridge cover.

4. Locate the X-axis rails and grease fittings (see Figure 6-5).

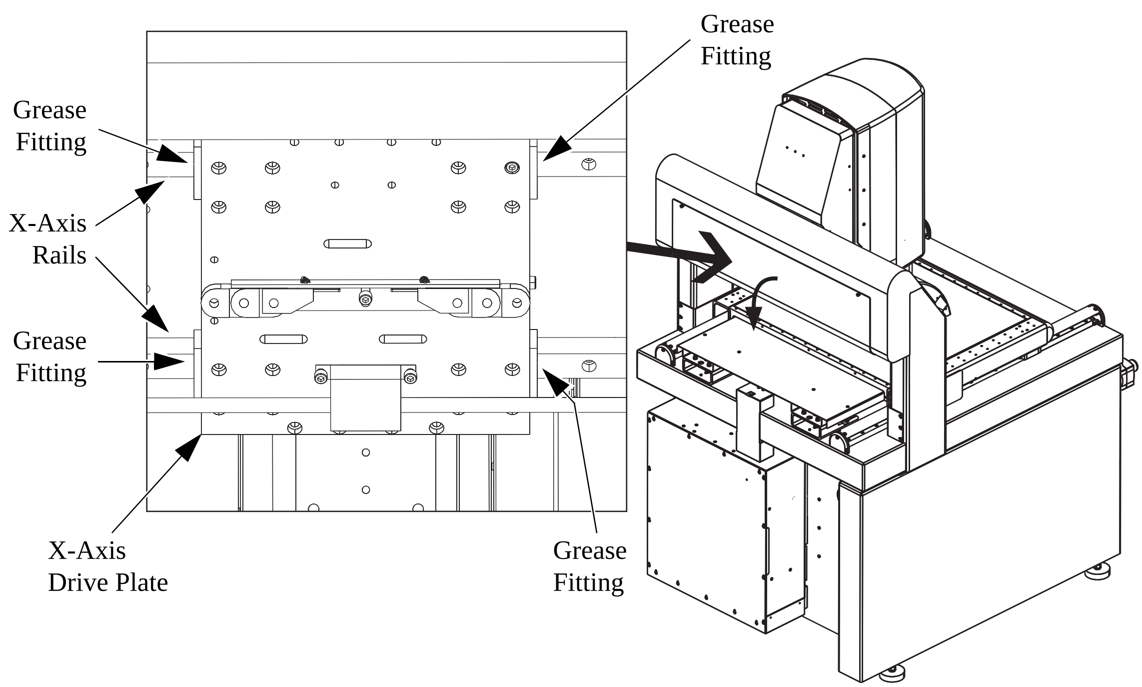


Figure 6-5 Cleaning and Lubricating the X-Axis Rails

5. Use clean, lint-free toweling to wipe the exposed X-axis rails. Make sure the rails are clean before continuing.

Caution: Do not apply anything other than NSK PS2 lubricant to the X-axis transport. **Doing so will permanently damage the machine.**

6. Use a grease gun and the four X-axis grease fittings (located on either side of the X-axis drive plate) to replenish the X-axis grease supply. **Use 2.0 cm^3 (0.12 in^3) of NSK PS2 lubricant.**

7. Close the rear bridge cover.

8. Power up the system and launch the VMS software.

9. Use the joystick to drive the X-axis transport from side to side along the full length of X travel several times to distribute the grease evenly along the rails.

10. Power down the system and disconnect the power cord from the power source.

11. Open the rear bridge cover and wipe off any excess grease that may have accumulated on the rails. Close the rear bridge cover when finished.

6.5.2 Cleaning & Lubricating the Y-Axis Guide Rails

1. Use the joystick to drive the Y-axis transport to the approximate center of its travel.

2. Power down the system and disconnect the power cord from the power source.

3. Use clean, lint-free toweling to wipe the exposed Y-axis rails (see Figure 6-6). Make sure the rails are clean before continuing.

4. Power up the system and launch the VMS software.

5. Use the joystick to drive the Y-axis transport to the rear limit of its travel, which provides access to all four Y-axis grease fittings (see Figure 6-6).

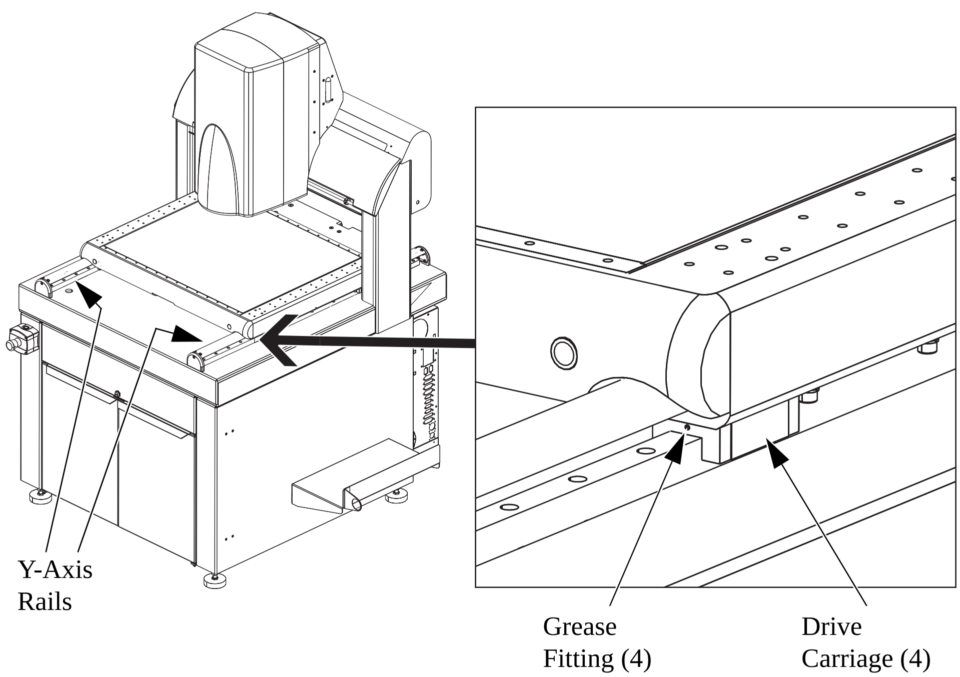


Figure 6-6 Cleaning and Lubricating the Y-Axis Rails

6. Power down the system and disconnect the power cord from the power source.

Caution: Do not apply anything other than NSK PS2 lubricant to the Y-axis transport. **Doing so will permanently damage the machine.**

7. Use a grease gun and the four Y-axis grease fittings (see Figure 6-6) to replenish the Y-axis grease supply. **Use 2.0 cm^3 (0.12 in^3) of NSK PS2 lubricant.**

8. Power up the system and launch the VMS software.

9. Use the joystick to drive the Y-axis transport back and forth along the full length of Y travel several times to distribute the grease evenly along the rails.

10. Power down the system and disconnect the power cord from the power source.

11. Wipe off any excess grease that may have accumulated on the rails.

6.6 Cleaning the Magnification Lens

Materials Required

Materials Required
Non-solvent lens cleaner
Cotton swab
Clean, soft, lint-free cloth

1. If the system is equipped with the Programmable Ring Light (PRL), move the PRL to the **0** setting (from within the VMS software) to provide access to the magnification lens.

2. Unscrew (CCW) the magnification lens from the lens tube (see Figure 6-7).

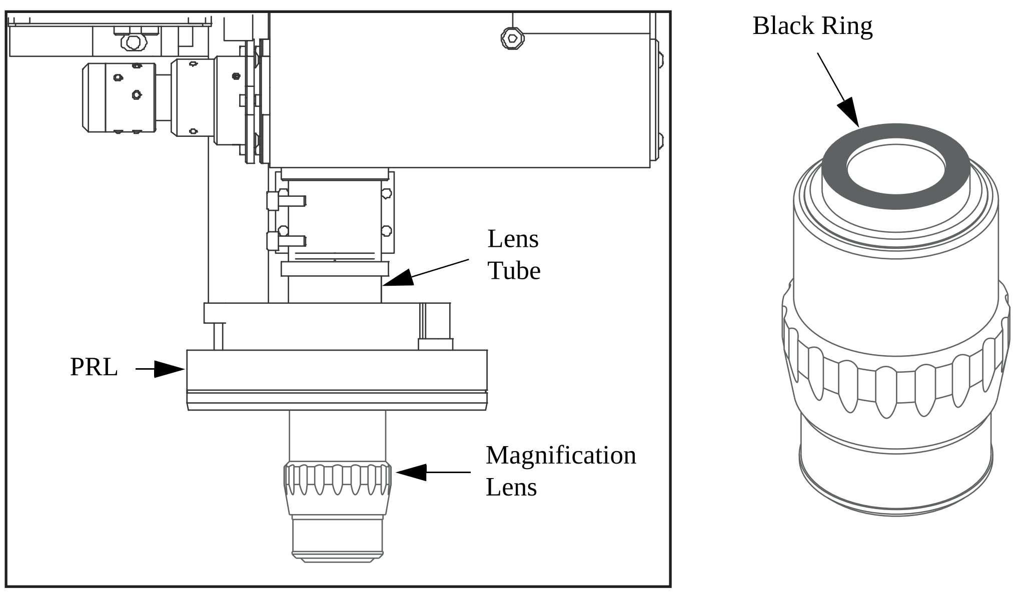


Figure 6-7 Removing the Magnification Lens

3. Check the threaded end of the magnification lens and verify that the black ring is intact. There should be no shiny surfaces between the outer diameter of the glass lens and the outer diameter of the threads, when looking into the threaded end of the lens. Replace the black ring if necessary.

4. Use a cotton swab and non-solvent lens cleaner to lightly moisten the lens glass at one end of the magnification lens. Make sure the lens cleaner does not get into the magnification lens.

5. Use a clean, soft, lint-free cloth to wipe the lens glass and remove any residual dirt. Start at the center of the lens and work toward the edges. Repeat as necessary until the lens is clean.

6. Repeat Step 4 and Step 5 to clean the lens glass at the other end of the magnification lens.

7. Carefully re-install the magnification lens by screwing (CW) it into the threaded opening in the lens tube.

8. Repeat the above procedure to check and clean all other magnification lenses.

6.7 Cleaning the LED Programmable Ring Light (PRL)

Materials Required
Non-solvent lens cleaner
Clean, soft, lint-free cloth

1. Move the Programmable Ring Light (PRL) assembly to the **0** setting (from within the VMS software) to provide access to the magnification lens.
2. Unscrew (CCW) the magnification lens from the lens tube (see Figure 6-7 on page 61).
3. Use a clean, soft, lint-free cloth moistened with lens cleaner to clean the outer mirror (see Figure 6-8).

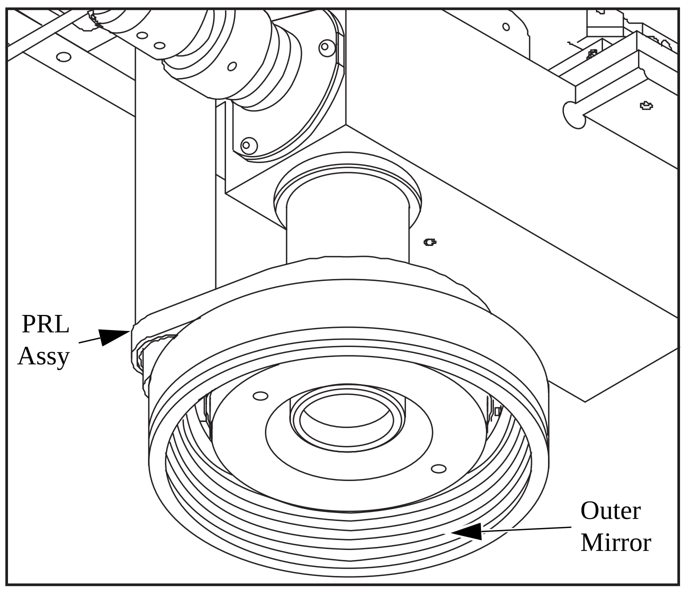


Figure 6-8 Cleaning the Programmable Ring Light

4. Gently wipe the surface dry.
5. Screw (CW) the magnification lens into the threaded opening in the lens tube without touching the cleaned surfaces of the PRL.

6.8 Checking for Dirt in the Images of the Video Cameras

1. Move the Ronchi Shuttle to the center position (between grids).

2. Install a 1X lens, and focus on a mirror (dirt or scratches).

3. Set the light level for a reasonably light image, and look for “dark blobs” caused by dust in the optical system. Use the following rules to locate the dust:

   - If the dust moves when you drive the X-axis and Y-axis transports, the dust is on the mirror.

   - If the dust does not go out of focus when you drive the Z-axis transport, dust is on the camera sensor. Remove the High and/or Low Mag cameras in a dust-free environment, clean them, and perform the dual magnification optical system adjustments (see ***Dual Magnification Optical System Adjustments*** on page 120).

   - By moving in Z below the focus position, you will be able to focus on dirt on the coaxial illuminator (above the shuttle). Clean the illuminator, if necessary.

   - By moving in Z above the focus position, you will be able to focus on dirt on the coaxial illumination projector lens. If it is on the upper surface, blow clean air inside the tube to get rid of it.

6.9 Verifying Proper System Operation

Run an inspection program on the system to ensure that the system is functioning properly. If necessary, refer to Section 7 for information about troubleshooting the system.

Troubleshooting

Chapter 7

7.1 What This Chapter Contains

This chapter helps you identify the cause of system problems. Use this chapter only to **diagnose** problems. Refer to Chapters 8 and 9 to make required adjustments and to replace parts.

This chapter covers:

- DSP Multi Axis PCBA Diagnostic LEDs & Test Points
- Dual Mag Optics PCBA Diagnostic LEDs & Test Points
- Z Brake Control PCBA Diagnostic LEDs & Test Points
- LED Driver PCBA Diagnostic LEDs & Test Points
- Measuring the Resistance of the Drewire Terminations
- Identifying Problems With the Benchmark 450 System
- Identifying Problems with the System Computer & User-Interface Components
- Recovering from Unexpected Z-Axis Contact

7.2 Before You Begin

Warning: Unless instructed otherwise, always power down the system and disconnect the power cord from the power supply while troubleshooting (see ***System Lockout*** on page 14).

Warning: The risk of electrical shock is present whenever the covers are removed from the machine. To avoid exposure to high voltage, never remove the covers from the flat-panel display or system power supplies.

Caution: Protect the system from electrostatic damage by performing these procedures at a static-safe workstation and wearing a ground strap. If a ground strap is not available, follow these guidelines:

- Work in an uncarpeted area.
- Discharge static electricity before touching electronic components by touching a known-grounded object.
- Do not touch components on printed circuit boards, except as directed.

Before you begin troubleshooting, note that:

- If you encounter a problem you are unable to resolve on your own, contact the Customer Support HelpDesk (see ***Where to Get Help*** on page 4).
- The phrase “not connected” and the term “disconnected” can signify that the connector is not fully seated. A wire can be broken inside its insulator due to crimping, pinching, or over-flexing.
- **This manual does not provide information on the repair of faulty PCBAs, and we strongly suggest that you do not attempt to repair them.** Contact the Customer Support HelpDesk (see ***Where to Get Help*** on page 4) for replacement boards.

7.3 DSP Multi Axis PCBA Diagnostic LEDs & Test Points

The DSP Multi Axis PCBA has several diagnostic LEDs and test points that are useful in diagnosing system problems.

7.3.1 DSP Multi Axis PCBA Diagnostic LEDs

The illustration below and the table on the next page provide an overview of the diagnostic LEDs on the DSP Multi Axis PCBA.

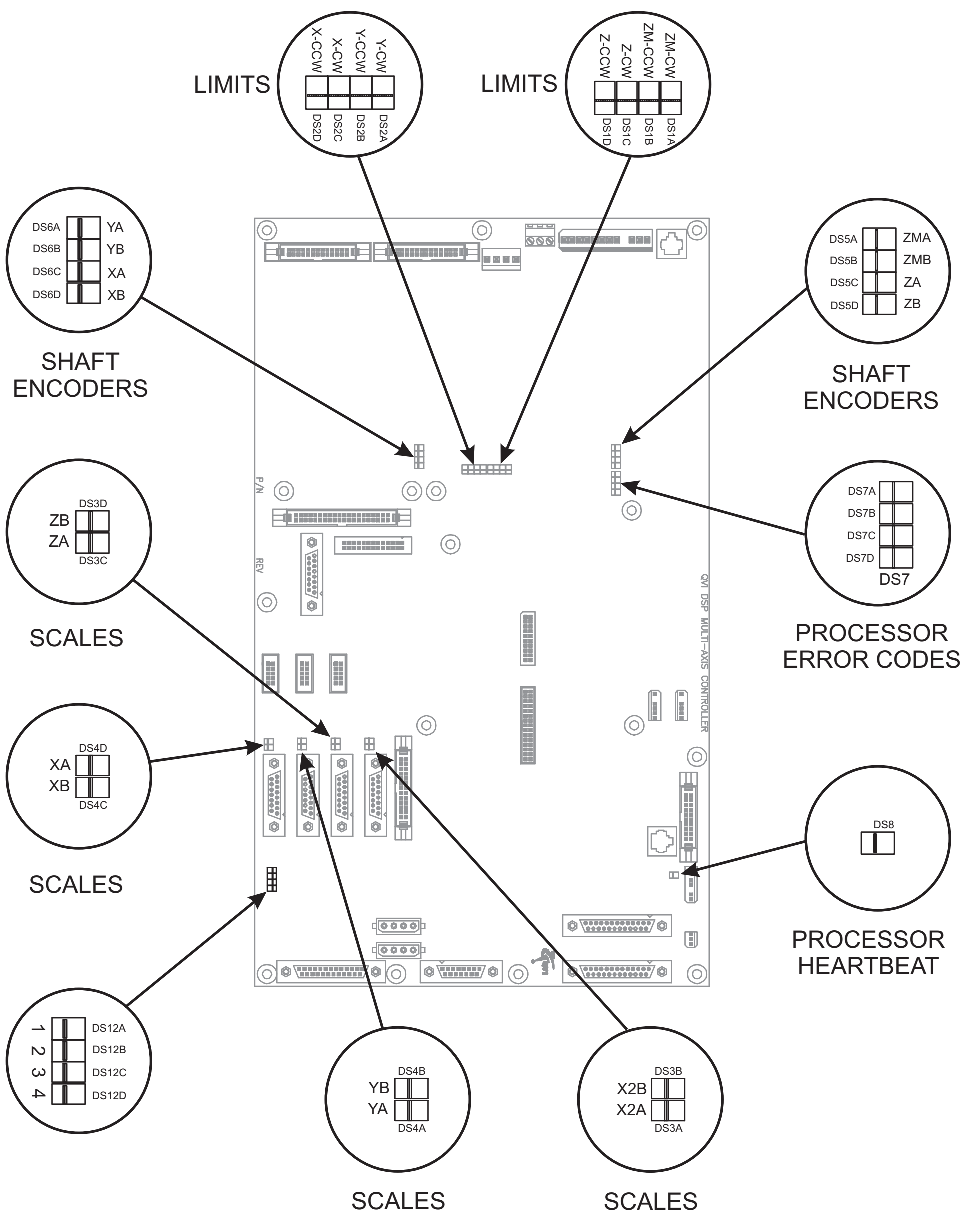


Figure 7-1 Location of Diagnostic LEDs on the DSP Multi Axis PCBA

LED(s)	What It Monitors	Description
DS1 and DS2	X-, Y-, and Z-Axis Limits	• **LED lit:** indicates limit not encountered • **LED not lit:** indicates limit encountered
DS3 and DS4	X-, Y-, and Z-Axis Scales (A and B channel input states)	Indicates whether or not the scales are operating properly: • LEDs should indicate quadrature (see ***Quadrature*** on page 69)
DS5	Z-Axis Shaft Encoders (A and B channel input states)	Indicates whether or not the Z-axis shaft encoders are operating properly: • LEDs should indicate quadrature (see ***Quadrature*** on page 69)
DS7	E-Stop Codes	See ***Diagnostic LED DS7 E-Stop Codes*** on page 70.
DS8	Processor Heartbeat	Indicates whether or not the software is running and the CPU is processing data: • **LED lit (solid):** indicates power on, but no mini-booter loaded • **LED lit (fast blink):** indicates mini-booter loaded • **LED lit (slow blink):** indicates `DSP.OUT` loaded and running

7.3.1.1 Quadrature

The diagnostic LEDs that normally indicate quadrature signals include:

- **DS3** for the Z-axis and extra scales (A and B channels)
- **DS4** for the X- and Y-axis scales (A and B channels for each axis)
- **DS5C** and **DS5D** for the Z-axis shaft encoders (A and B channels)

In general, quadrature signal is displayed on these LEDs in the following ways:

- An appropriate A/B channel pair (like X2A and X2B on DS3) exhibits a constantly changing On/Off pattern as the stage (X, Y, or Z) moves in one direction or the other, as indicated below.

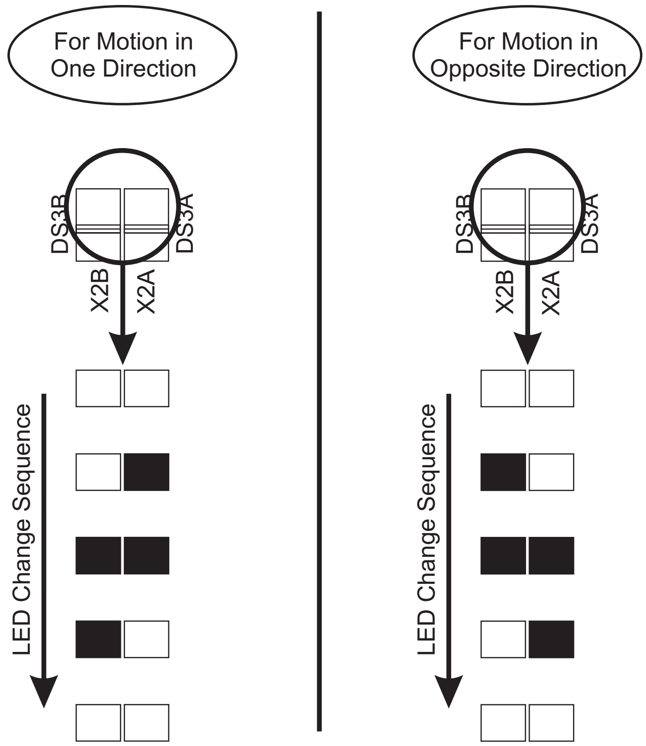


Figure 7-2 An Example of Quadrature Signal

- Depending on the direction of motion, the A/B channel LEDs will appear to “roll” in one direction or the other.

- If the A/B channel LEDs **do not track** with axis motion as described above (for example, if one or both remain fixed On/Off, or if both come on or go off suddenly when the stages move) there is a problem.

- Remember that the LEDs change with **each least count of motion** at the scale or shaft.

7.3.1.2 Diagnostic LED DS7 E-Stop Codes

Diagnostic LED DS7 can be useful in diagnosing system anomalies and serves two purposes:

- If the system enters E-Stop, DS7 indicates the source of E-Stop.
- DS7 indicates when specific scale limits have been encountered.

Note: Be prepared to provide the status of LEDs DS7 and DS8 (heartbeat) whenever contacting the Customer Support HelpDesk.

In its normal “monitoring” state, the four LEDs within DS7 roll rapidly back and forth. If the machine has entered E-Stop for any reason, the individual LEDs will flash in a specific pattern, as indicated on the next page.

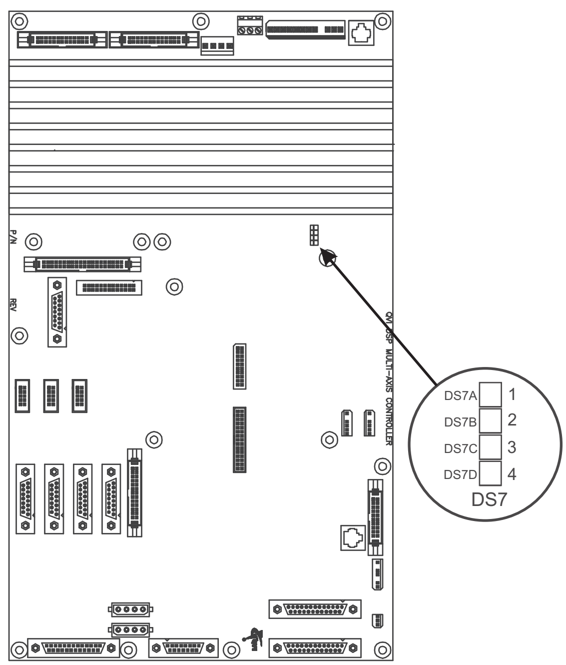
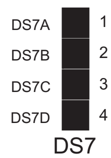


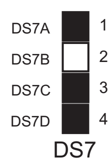
Figure 7-3 Approximate Location of Diagnostic LED DS7

Flashing LED Pattern	Source of E-Stop

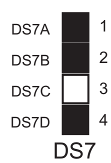


Initial power-up

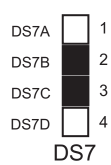
Excess position error, X-axis



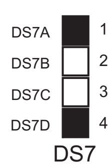
Excess position error, Y-axis



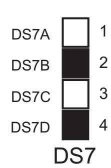
Excess position error, Z-axis



Loss of motor power (connector J13)



Start/Stop button on the joystick has been pressed



Loss of continuity between pins 1 and 2 on P401

■ Indicates LED is lit

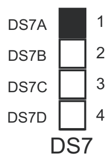
□ Indicates LED is off

7.3.2 Magnetic Limit Codes (DS7)

Again, in its normal “monitoring” state, the four LEDs within DS7 roll rapidly back and forth. If an integral magnetic scale limit is encountered, the system will not usually enter E-Stop. However, magnetic limits will cause individual LEDs to light up in a specific pattern, as indicated below.

Note: If multiple magnetic scales are encountered, more than one LED will light up concurrently.

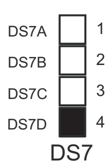
Steady LED Pattern | **Error**



Encountered magnetic limit, X-axis

Encountered magnetic limit, Y-axis

Encountered magnetic limit, Z-axis



Encountered magnetic limit, extra scale

■ Indicates LED is lit

□ Indicates LED is off

7.3.3 DSP Multi Axis PCBA Test Points

The illustration below and the table on the next page provide an overview and the approximate location of the test points on the DSP Multi Axis PCBA.

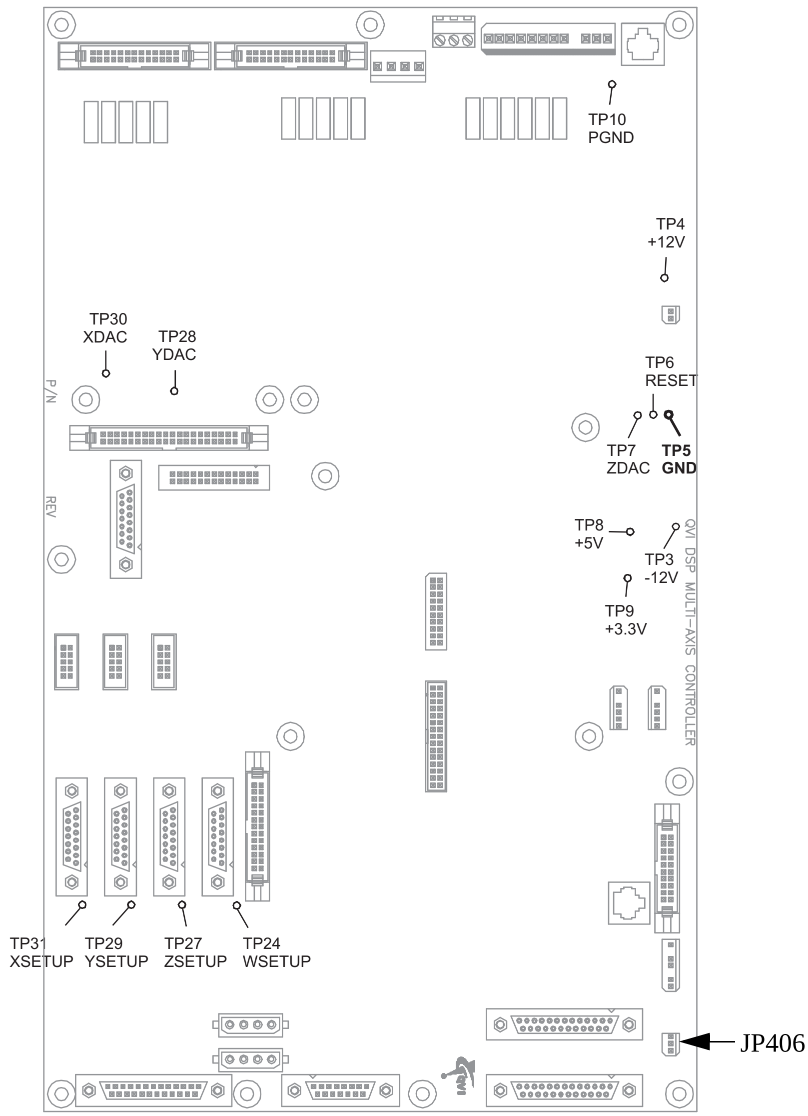


Figure 7-4 Location of Test Points on the DSP Multi Axis PCBA

Test Point(s)	What Does It Test?	Function
TP3	-12VDC	Test voltage
TP4	12VDC	Test voltage
TP5	—	Ground
TP10	—	Z-axis motor power ground
TP6	—	Reset
TP7	Z-Axis Digital/Analog Converter	Test Z-axis DAC
TP8	5VDC	Test voltage
TP9	3.3VDC	Test voltage
TP15	—	Ground
TP24	Extra Scale	Test extra scale setup
TP27	Z-Axis Scale	Test Z-axis scale setup
TP28	Y-Axis Digital/Analog Converter	Test Y-axis DAC
TP29	Y-Axis Scale	Test Y-axis scale setup
TP30	X-Axis Digital/Analog Converter	Test X-axis DAC
TP31	X-Axis Scale	Test X-axis scale setup
TP32	X Potentiometer Input to DSP	Useful in troubleshooting system anomalies. For more information, contact the Customer Support HelpDesk
TP33	Z Potentiometer Input to DSP	
TP34	Y Potentiometer Input to DSP	
TP41	—	
TP42	X Potentiometer Input to A/D Converter	
TP43	Y Potentiometer Input to A/D Converter	
TP44	Z Potentiometer Input to A/D Converter	

7.4 Dual Mag Optics PCBA Diagnostic LEDs & Test Points

The Dual Mag Optics PCBA has several diagnostic LEDs and test points that are useful in diagnosing system problems.

7.4.1 Dual Mag Optics PCBA Diagnostic LEDs

The illustration below and the table on the next page provide an overview of the diagnostic LEDs on the Dual Mag Optics PCBA.

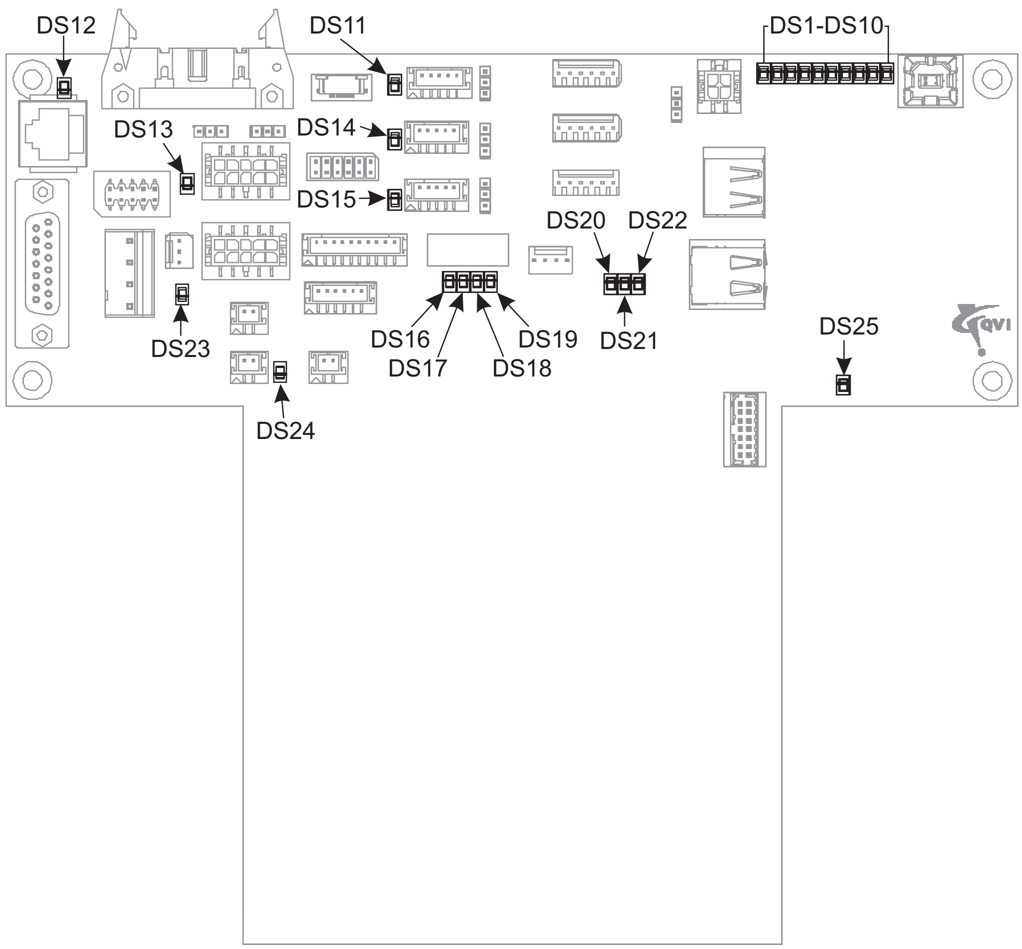


Figure 7-5 Location of Diagnostic LEDs on the Dual Mag Optics PCBA

LED(s)	What It Monitors	Description
DS1 & DS2	USB micro processor	• **DS1 on** (green): indicates USB micro processor is functioning properly • **DS2 on** (amber)**:** indicates USB micro processor is not functioning properly and there is a problem with the board
DS3 & DS4	USB device connected to P5	• **DS3 on** (green)**:** indicates the USB device connected to P5 is functioning properly • **DS4 on** (amber)**:** indicates the USB device connected to P5 is not functioning properly
DS5 & DS6	USB device connected to connector P6B	• **DS5 on** (green)**:** indicates the USB device connected to connector P6B is functioning properly • **DS6 on** (amber)**:** indicates the USB device connected to connector P6B is not functioning properly
DS7 & DS8	USB device connected to P6A	• **DS7 on** (green)**:** indicates the USB device connected to connector P6A is functioning properly • **DS8 on** (amber)**:** indicates the USB device connected to connector P6A is not functioning properly
DS9	USB micro processor heartbeat	LED should blink at approximately 1 flash/second
DS10	USB micro processor	If LED is on, there is a problem with the USB micro processor
DS11	—	Reserved for future use
DS12	5VDC	• **LED on:** indicates 5VDC is present • **LED off:** indicates 5VDC is not present

LED(s)	What It Monitors	Description
DS13	12VDC	• **LED on:** indicates 12VDC is present • **LED off:** indicates 12VDC is not present
DS14	—	Reserved for future use
DS15	—	Reserved for future use
DS16	—	Reserved for future use
DS17	—	Reserved for future use
DS18	—	Reserved for future use
DS19	—	Reserved for future use
DS20	Reserved for Engineering use	—
DS21	Reserved for Engineering use	—
DS22	Reserved for Engineering use	—
DS23	—	Reserved for future use
DS24	Surface Illuminator/ Grid Projector LED intensity	The intensity of the LED tracks the illumination changes made in the software
DS25	Heartbeat	LED should blink at approximately 1 flash/second

7.4.2 Dual Mag Optics PCBA Test Points

The illustration below and the table on the next page provide an overview of the test points on the Dual Mag Optics PCBA.

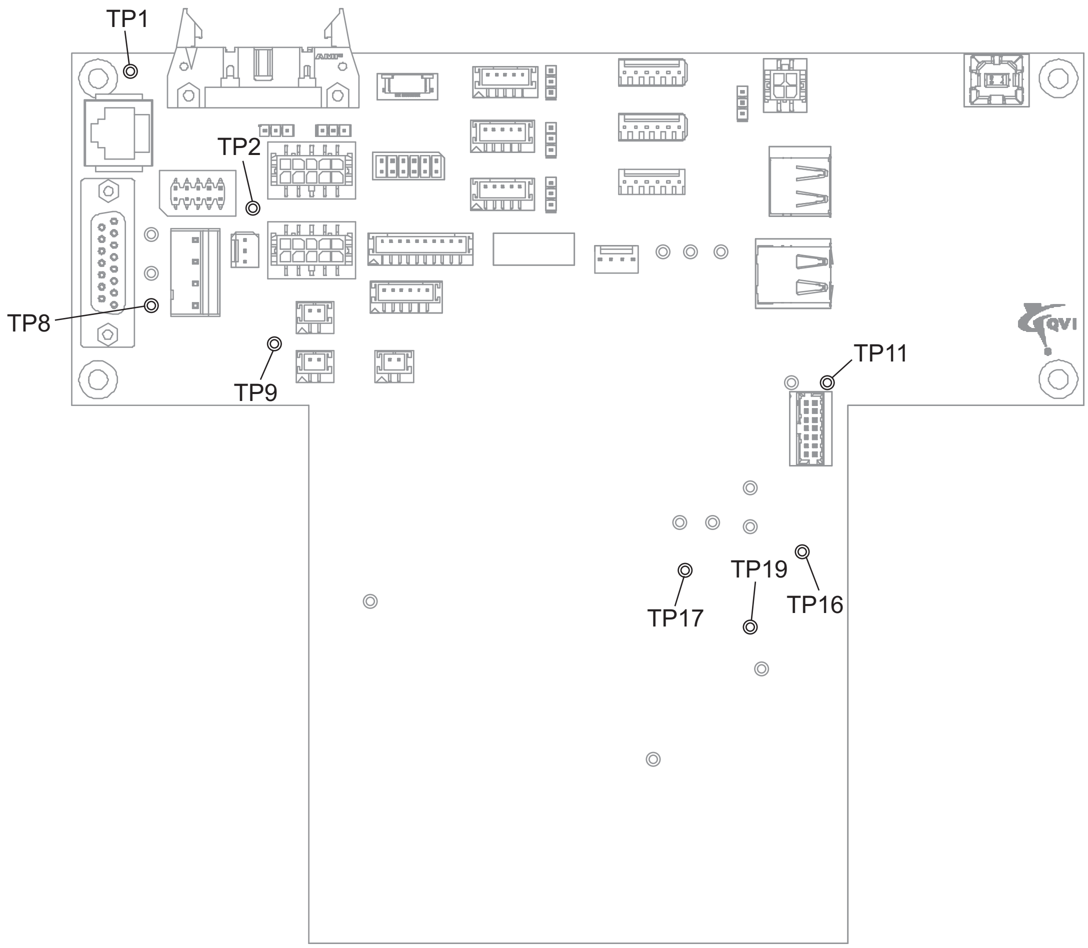


Figure 7-6 Location of Test Points on the Dual Mag Optics PCBA

Test Point(s)	What Does It Test?	Function
TP1	5VDC (±5%)	Test voltage
TP2	12VDC (±10%)	Test voltage
TP8	15VDC (±10%)	Test voltage
TP9	-15VDC (±5%)	Test voltage
TP11	3.3VDC (±5%)	Test voltage
TP16	—	Ground
TP17	24VDC (±10%)	Test voltage
TP19	2.5VDC (±5%)	Test voltage

7.5 Z Brake Control PCBA Diagnostic LEDs & Test Points

The Z Brake Control PCBA has several diagnostic LEDs and test points that are useful in diagnosing system problems.

7.5.1 Z Brake Control PCBA Diagnostic LEDs

The illustration below and the table on the next page provide an overview of the diagnostic LEDs on the Z Brake Control PCBA.

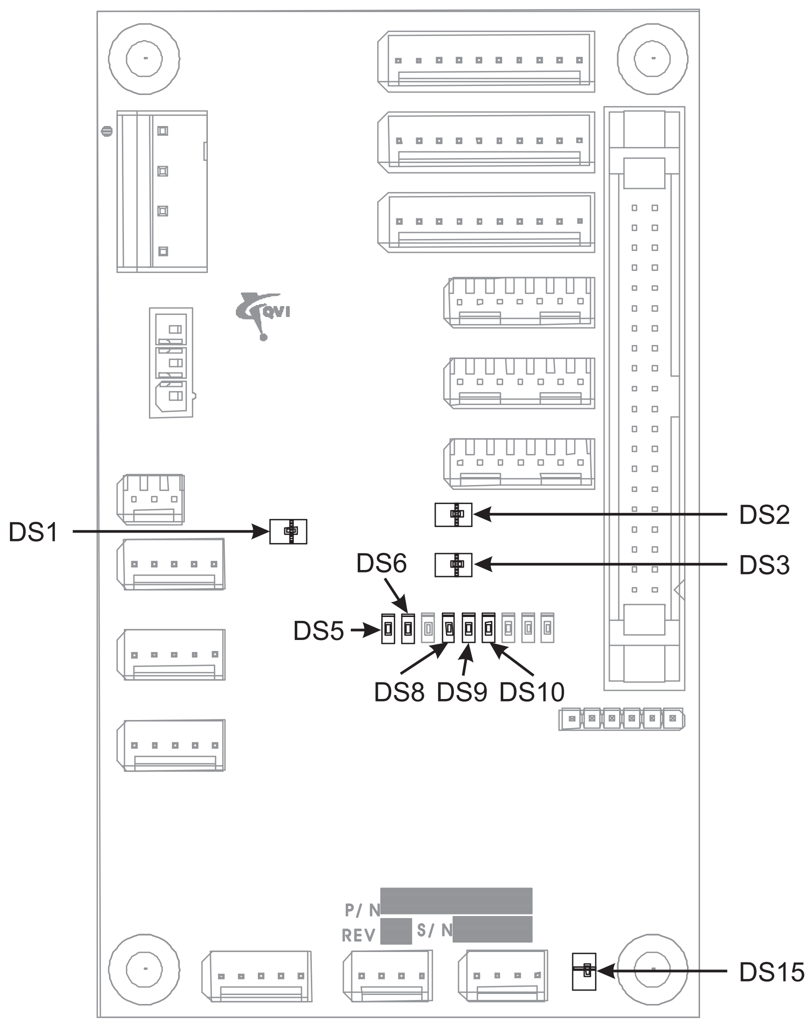


Figure 7-7 Location of Diagnostic LEDs on the Z Brake Control PCBA

Caution: The jumpers on the Z Brake Control PCBA (not shown in Figure 7-7) have been set at the factory for your particular system. Do not adjust these jumper settings without consulting the Customer Support HelpDesk (see ***Where to Get Help*** on page 4).

LED(s)	What It Monitors	Description
DS1	24VDC	• **LED lit:** indicates 24VDC is present • **LED not lit:** indicates 24VDC is not present
DS2	5VDC	• **LED lit:** indicates 5VDC is present • **LED not lit:** indicates 5VDC is not present
DS3	3.3VDC	• **LED lit:** indicates 3.3VDC is present • **LED not lit:** indicates 3.3VDC is not present
DS5	Stop signal from Z Brake Control PCBA to DSP Multi Axis PCBA	• **LED lit:** indicates stop signal has been sent from the Z Brake Control PCBA to the DSP Multi Axis PCBA • **LED not lit:** indicates stop signal has not been sent from the Z Brake Control PCBA to the DSP Multi Axis PCBA
DS6	Stop signal from DSP PCBA	• **LED lit:** DSP Multi Axis PCBA is in Stop Mode • **LED not lit:** DSP Multi Axis PCBA is not in Stop Mode
DS8	AC Power	• **LED lit:** indicates AC sense circuit does not detect AC power • **LED not lit:** indicates AC sense circuit detects AC power
DS9	Brake Power	• **LED lit:** indicates the power supply connected to J113 on the Z Brake Control PCBA has dropped more than 5VDC below its expected value • **LED not lit:** indicates the power supply connected to J113 on the Z Brake Control PCBA has not dropped more than 5VDC below its expected value

LED(s)	What It Monitors	Description
DS10	Safety Relay	• **LED lit:** indicates E-Stop switch has been pressed • **LED not lit:** indicates E-Stop switch has not been pressed
DS15	Heartbeat	• **LED blinking:** indicates CPLD is functioning properly • **LED lit (not blinking):** indicates CPLD is defective • **LED not lit:** indicates less than 4.6VDC is present (in this case, DS5 and DS6 will be lit)

7.5.2 Z Brake Control PCBA Test Points

The illustration below and the table on the next page provide an overview of the test points on the Z Brake Control PCBA.

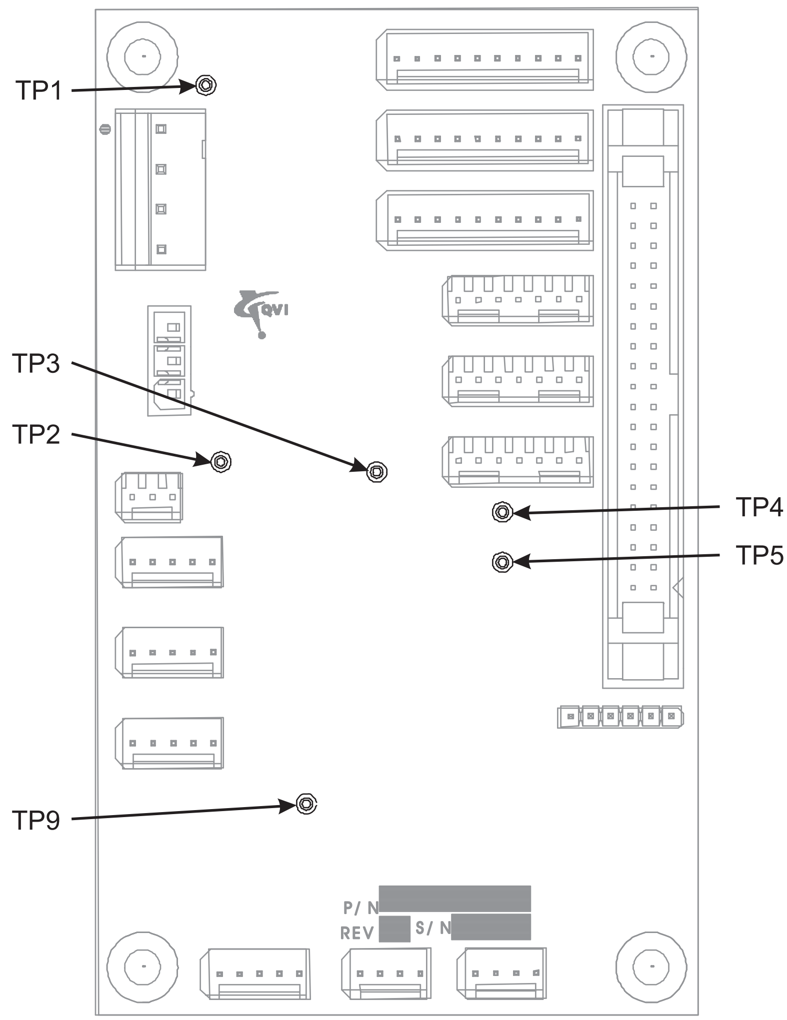


Figure 7-8 Test Points on the Z Brake Control PCBA

Test Point(s)	What Does It Test?	Function
TP1	Brake Power (48VDC)	Test voltage
TP2	24VDC (switched)	Test voltage
TP3	—	Ground
TP4	5VDC	Test voltage
TP5	3.3VDC	Test voltage
TP9	—	Ground

7.6 LED Driver PCBA Diagnostic LEDs & Test Points

The LED Driver PCBA has several diagnostic LEDs and test points that are useful in diagnosing system problems.

7.6.1 LED Driver PCBA Diagnostic LEDs

The illustration below and the table on the next page provide an overview of the diagnostic LEDs on the LED Driver PCBA.

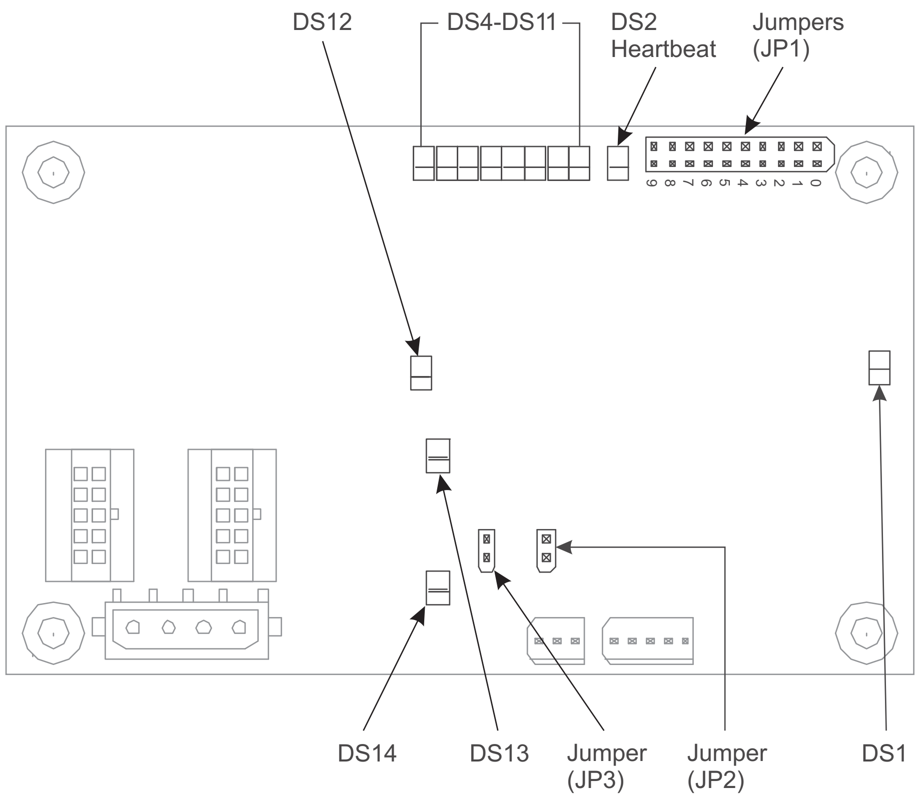


Figure 7-9 Location of Diagnostic LEDs on the LED Driver PCBA

Caution: The jumpers on the LED Driver PCBA have been set at the factory for your particular system. Do not adjust these jumper settings without consulting the Customer Support HelpDesk (see ***Where to Get Help*** on page 4).

LED(s)	What It Monitors	Description
DS1	Substage LED Intensity	The intensity of the LED tracks the illumination changes made in the software
DS2	Heartbeat	LED should blink at approximately 1 flash/second
DS1, DS4-DS11	Diagnostic LED Functions	Used to troubleshoot system anomalies; contact the Customer Support HelpDesk; see ***Where to Get Help*** on page 4 for more information.
DS12	3.3VDC	• **LED on:** indicates 3.3VDC is present • **LED off:** indicates 3.3VDC is not present
DS13	5VDC	• **LED on:** indicates 5VDC is present • **LED off:** indicates 5VDC is not present
DS14	12VDC	• **LED on:** indicates 12VDC is present • **LED off:** indicates 12VDC is not present

7.6.2 LED Driver PCBA Test Points

The illustration below and the table on the next page provide an overview of the test points on the LED Driver PCBA.

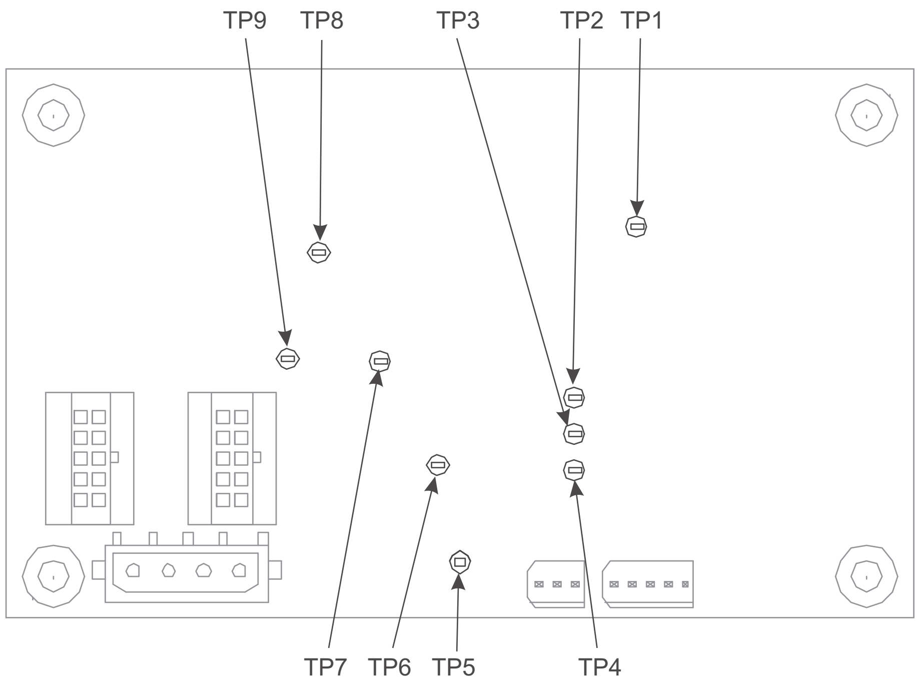


Figure 7-10 Location of Test Points on the LED Driver PCBA

Test Point(s)	What Does It Test?	Function
TP1	Reserved for Engineering use	—
TP2	DWI SYNC RX	—
TP3	DWI DATA RX	—
TP4	DWI DATA TX	—
TP5	12VDC	Test voltage
TP6	5VDC	Test voltage
TP7	3.3VDC	Test voltage
TP8	—	
TP9	-15VDC	Test voltage

7.7 Measuring the Resistance of the Drewire Terminations

Caution: Whenever handling electrical or electronic components, take the necessary precautions to prevent the discharge of static electricity.

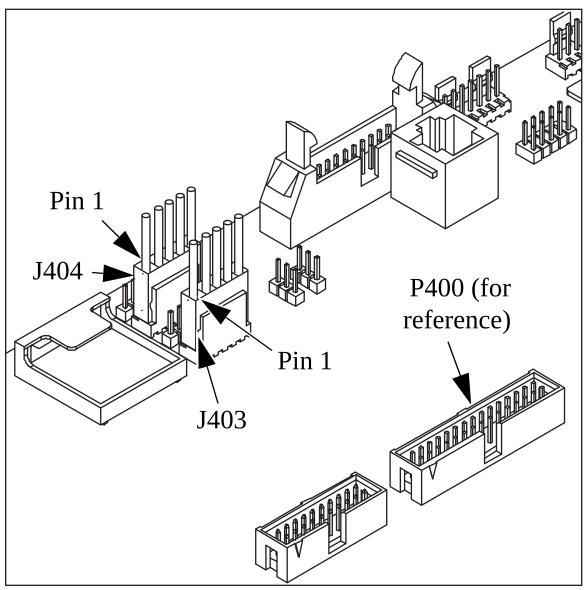
1. Power down the system and disconnect the power cord from the power source. The machine power must be off when measuring the resistance of the terminations.

2. Remove the electronics enclosure panel — see ***Removing the Electronics Enclosure Panel*** on page 165.

Caution: Do not disconnect the cables that are connected to P403 and P404 on the DSP Multi Axis PCBA.

3. Use a Digital Multimeter (DMM) to measure the resistance between pins 1 and 3 on connector J403 (connects to P403) or J404 (connects to P404). Record this reading.

4. Repeat Step 3 to measure the resistance between pins 4 and 5 on connector J403 or J404. Again, record this reading.



5. Be prepared to provide this information when contacting the Customer Support HelpDesk.

7.8 Identifying Problems With the Benchmark 450 System

This section is intended to help you diagnose system problems. This information is only intended as a reference, and it is recommended that the steps taken to resolve the problem be performed by a factory trained individual within your facility.

Please contact the Customer Support HelpDesk (see ***Where to Get Help*** on page 4) for assistance and/or training information.

7.8.1 Start-Up Troubleshooting

Symptom	Possible Causes	Possible Solutions
System does not power up when you power up the system computer.	Power switch on the machine is in the OFF position.	Power up the machine.
	Machine power cord is disconnected from the machine or the main power source.	Verify that the power cord is connected to the machine and the main power source.
	Computer power cord is disconnected from the computer or the main power source.	Verify that the power cord is connected to the computer and the main power source.
	Soft start extension cable is disconnected from the machine or the computer.	Verify that the soft start extension cable is connected to the machine and computer.
	No AC power present.	Determine the reason why there is no AC power and fix the problem.
	Computer BIOS not configured to power on after a power failure.	Contact the Customer Support HelpDesk; see ***Where to Get Help*** on page 4 for more information.
All axes are functional, but there is no coaxial and/or backlight illumination.	—	Refer to the Illumination Troubleshooting section on page 91.
Illumination is OK, but there is no stage movement.	—	Refer to the Motion Troubleshooting section on page 95.

Symptom	Possible Causes	Possible Solutions
No illumination or stage movement.	One of the E-Stops has been pressed.	1. Reset the E-Stop by twisting the knob in the direction of the arrows. 2. Clear the software message. 3. Press the **Stop/Start** button on the joystick. 4. Re-zero the stages.

7.8.2 Illumination Troubleshooting

Symptom	Possible Causes	Possible Solutions
Dim or no coaxial (surface) illumination.	Dirty magnification lens.	Clean the magnification lens; see ***Cleaning the Magnification Lens*** on page 61.
	System is not configured correctly.	Select **Setup | Options | System** in the VMS main menu and verify that all options are correct. If necessary, contact the Customer Support HelpDesk (see ***Where to Get Help*** on page 4) for more information.
	System parameter settings are incorrect (only applies to optional LED grid projector/ surface illuminator).	Contact the Customer Support HelpDesk (see ***Where to Get Help*** on page 4) for more information.
	Loose or faulty cabling to the Dual Mag Optics PCBA.	• Observe LED DS24 on the Dual Mag Optics PCBA as you adjust the light level in the software. If the intensity of the LED **does not track** the illumination changes made in the software, there may be a problem with the cabling to the board. • Verify that all cable connections (and interconnecting cables) to the Dual Mag Optics PCBA are secure. • Reconnect or replace any disconnected or damaged cables.

Symptom	Possible Causes	Possible Solutions
Dim or no coaxial (surface) illumination (continued).	Loose or faulty cabling to the coaxial illuminator.	• Observe LED DS24 on the Dual Mag Optics PCBA as you adjust the light level in the software. If the intensity of the LED **tracks** the illumination changes made in the software, there may be a problem with the cabling to the illuminator. • Verify that all cable connections (and interconnecting cables) to the illuminator are secure. • Reconnect or replace any disconnected or damaged cables.
	Defective Dual Mag Optics PCBA.	• Check LED DS25 (heartbeat) on the Dual Mag Optics PCBA — if the system is powered up, the LED should blink at approximately 1 flash/second. • Observe LED DS24 on the Dual Mag Optics PCBA as you adjust the light level in the software. If the intensity of the LED **does not track** the illumination changes made in the software and cabling is not the problem, there may be a problem with the Dual Mag Optics PCBA. • Check voltages on the Dual Mag Optics PCBA; see ***Dual Mag Optics PCBA Test Points*** on page 78. • Replace the Dual Mag Optics PCBA if necessary; see ***Replacing the Dual Mag Optics PCBA*** on page 202.
	Burnt out LEDs	Contact the Customer Support HelpDesk (see ***Where to Get Help*** on page 4) for more information.
	Defective coaxial illuminator.	Contact the Customer Support HelpDesk (see ***Where to Get Help*** on page 4) for more information.

Symptom	Possible Causes	Possible Solutions
Dim or no coaxial (surface) illumination (continued).	Improper Drewire terminations (very rare).	• Measure the resistance of the Drewire terminations; see ***Measuring the Resistance of the Drewire Terminations*** on page 89. • Contact the Customer Support HelpDesk (see ***Where to Get Help*** on page 4) for more information.
Dim or no backlight illumination.	Dirty stage glass.	Clean the stage glass; see ***Cleaning the Stage Glass*** on page 49.
	System is not configured correctly.	Select **Setup | Options | System** in the VMS main menu and verify that all options are correct. If necessary, contact the Customer Support HelpDesk (see ***Where to Get Help*** on page 4) for more information.
	Loose or faulty cabling to the LED Driver PCBA.	• Observe LED DS1 on the LED Driver PCBA as you adjust the light level in the software. If the intensity of the LED **does not track** the illumination changes made in the software, there may be a problem with the cabling to the board. • Verify that all cable connections (and interconnecting cables) to the LED Driver PCBA are secure. • Reconnect or replace any disconnected or damaged cables.
	Loose or faulty cabling to the substage illuminator.	• Observe LED DS1 on the LED Driver PCBA as you adjust the light level in the software. If the intensity of the LED **tracks** the illumination changes made in the software, there may be a problem with the cabling to the substage illuminator. • Verify that all cable connections (and interconnecting cables) to the substage illuminator are secure. • Reconnect or replace any disconnected or damaged cables.

Symptom	Possible Causes	Possible Solutions
Dim or no backlight illumination (continued).	Defective LED Driver PCBA.	• Check LED DS2 (heartbeat) on the LED Driver PCBA — when the system is powered up, the LED should blink at approximately 1 flash/second. • Observe LED DS1 on the LED Driver PCBA as you adjust the light level in the software. If the intensity of the LED **does not track** the illumination changes made in the software and cabling is not the problem, there may be a problem with the LED Driver PCBA. • Check voltages on the LED Driver PCBA; see ***LED Driver PCBA Test Points*** on page 87. • Replace the LED Driver PCBA if necessary; see ***Replacing the LED Driver PCBA*** on page 200.
	Defective substage illuminator.	Contact the Customer Support HelpDesk (see ***Where to Get Help*** on page 4) for more information.
	Improper Drewire terminations (very rare).	• Measure the resistance of the Drewire terminations (see ***Measuring the Resistance of the Drewire Terminations*** on page 89). • Contact the Customer Support HelpDesk (see ***Where to Get Help*** on page 4) for more information.
Ronchi grid is not operational.	Loose or faulty cabling between the system computer and the machine.	• Verify that all cable connections are correct and secure. • Reconnect or replace any disconnected or damaged cables.

7.8.3 Motion Troubleshooting

Symptom	Possible Causes	Possible Solutions
Joystick causes wrong or multiple axes to move.	Loose joystick connection to the machine.	Verify that the joystick is properly connected to the machine.
	VMS is not the only program in the Windows Start-Up menu.	Verify VMS is the only program in the Start-Up menu.
	Loose or faulty motion related cable connections.	• Verify that all motion related cables are properly connected and secure. • Reconnect or replace any disconnected or damaged cables.
	Defective joystick.	Perform the joystick troubleshooting procedure on page 108.
Axis drifts on power up.	Low +12VDC or -12VDC.	• Check power supply voltages. • Contact the Customer Support HelpDesk (see ***Where to Get Help*** on page 4) for more information.
	Defective joystick.	Perform the joystick troubleshooting procedure on page 108.
	DSP Multi Axis PCBA is not configured correctly.	Contact the Customer Support HelpDesk (see ***Where to Get Help*** on page 4) for more information.
All axes will not initialize.	Stop/Start button on the joystick has been pressed.	Press the **Stop/Start** button on the joystick.
	One of the E-Stops has been pressed.	1. Clear the software message. 2. Reset the E-Stop by twisting the knob in the direction of the arrows. 3. Press the **Stop/Start** button on the joystick. 4. Re-zero the stages.
	Loose remote E-Stop connection to the machine.	Verify that the remote E-Stop switch is properly connected to the machine.
	Faulty remote E-Stop switch.	Replace the remote E-Stop switch.
	Loose or faulty cabling to the DSP Multi Axis PCBA.	• Check and secure all cable connections to the DSP Multi Axis PCBA. • Reconnect or replace any disconnected or damaged cables.

Symptom	Possible Causes	Possible Solutions
All axes will not initialize (continued).	Loose or faulty cabling between the 48V power supply and the DSP Multi Axis PCBA.	• Verify that the power supply is properly connected to the DSP Multi Axis PCBA. • Verify that motor voltage is present on the DSP Multi Axis PCBA — check between the outermost pins on connector J13 on the DSP Multi Axis PCBA. • Reconnect or replace any disconnected or damaged cables.
	Defective 48V power supply.	• Check the power supply voltages. • Replace the power supply if necessary; see ***Replacing the Power Supplies*** on page 208.
	Defective DSP Multi Axis PCBA.	• Check LED DS8 (heartbeat) on the DSP Multi Axis PCBA — LED should be on (solid) or blinking. • Check LED DS7 on the DSP Multi Axis PCBA for error codes; see ***Diagnostic LED DS7 E-Stop Codes*** on page 70. • Check power supply voltages. • Replace the DSP Multi Axis PCBA if necessary; see ***Replacing the DSP Multi Axis PCBA*** on page 196.
X- or Y-axis stage will not initialize.	Stage may be stuck at the end of travel.	1. Press the remote E-Stop. 2. Manually position the X- or Y-axis stage to the center of its travel. 3. Clear the software message. 4. Reset the remote E-Stop switch by twisting the knob in the direction of the arrows. 5. Press the **Stop/Start** button on the joystick. 6. Re-initialize the stages.
	Loose or faulty cabling to the DSP Multi Axis PCBA.	• Check and secure all cable connections to the DSP Multi Axis PCBA. • Reconnect or replace any disconnected or damaged cables.

Symptom	Possible Causes	Possible Solutions
X- or Y-axis stage will not initialize (continued).	Defective motor on the affected axis.	Isolate problem axis and replace the defective motor; see ***Replacing the Motors*** on page 184
	Limit switch has been moved or removed.	Replace or re-install limit switch. For more information contact the Customer Support HelpDesk (see ***Where to Get Help*** on page 4) for more information.
Axis does not move in any direction.	One of the E-Stops has been pressed.	1. Clear the software message. 2. Reset the E-Stop by twisting the knob in the direction of the arrows. 3. Press the **Stop/Start** button on the joystick. 4. Re-zero the stages.
	Stop/Start button on the joystick has been pressed.	Press the **Stop/Start** button on the joystick.
	Loose remote E-Stop connection to the machine.	Verify that the remote E-Stop switch is properly connected to the machine.
	Faulty remote E-Stop switch.	Replace remote E-Stop switch.
	`DSP.OUT` was not downloaded during startup.	Reboot the metrology software.
	Loose or faulty motion related cable connections.	• Verify that all motion related cables are properly connected and secure. • Reconnect or replace any disconnected or damaged cables.
	Loose or faulty scale cables.	• Check for lost scale counts by zeroing the affected axis, moving a known distance along the axis, and comparing the reading displayed in the DRO to the nominal distance. • Check for proper scale operation by observing the corresponding diagnostic LEDs on the DSP Multi Axis PCBA as you *slowly* move along the affected axis—the LEDs should indicate quadrature (see ***Quadrature*** on page 69). • Check and secure all cable connections. • Reconnect or replace any disconnected or damaged cables.

Symptom	Possible Causes	Possible Solutions
Axis does not move in any direction (continued).	Loose or faulty cabling between the 48V power supply and the DSP Multi Axis PCBA.	• Verify that the 48V power supply is properly connected to the DSP Multi Axis PCBA. • Verify that motor voltage is present on the DSP Multi Axis PCBA — check between the outermost pins on connector J13 on the DSP Multi Axis PCBA. • Reconnect or replace any disconnected or damaged cables.
	Misaligned scale reader head.	• Isolate problem axis and check the scale reader head alignment along the full length of travel. • Re-align the scale reader head if necessary.
	Defective motor.	Isolate the problem axis and replace the defective motor. • If the X-axis is defective, see ***Replacing the X-Axis Motor*** on page 185. • If the Y-axis motor is defective, see ***Replacing the Y-Axis Motor*** on page 187. • If the Z-axis motor is defective, see ***Replacing the Z-Axis Motor*** on page 190.
	Defective scale reader head or reader head cable on the affected axis — LED DS7 on the DSP Multi Axis PCBA indicates an excess position error.	• Check for lost scale counts by zeroing the affected axis, moving a known distance along the axis, and comparing the reading displayed in the DRO to the nominal distance. • Check for proper scale operation by observing the corresponding diagnostic LEDs on the DSP Multi Axis PCBA as you *slowly* move along the affected axis—the LEDs should indicate quadrature (see ***Quadrature*** on page 69). • Replace the scale reader head if necessary; see ***Replacing the Scale Reader Heads*** on page 173.

Symptom	Possible Causes	Possible Solutions
Axis does not move in any direction (continued).	Defective 48V power supply.	• Check the power supply voltages. • Replace the 48V power supply if necessary; see ***Replacing the 48 Volt Power Supply*** on page 212.
	Defective DSP Multi Axis PCBA.	• Check LED DS8 (heartbeat) on the DSP Multi Axis PCBA—LED should be on (solid) or blinking. • Check LED DS7 on the DSP Multi Axis PCBA for error codes; see ***Diagnostic LED DS7 E-Stop Codes*** on page 70. • Check power supply voltages. • Replace the DSP Multi Axis PCBA if necessary; see ***Replacing the DSP Multi Axis PCBA*** on page 196.
	Incorrect or missing tuning parameters.	Contact the Customer Support HelpDesk (see ***Where to Get Help*** on page 4) for more information.
Axis only moves in one direction.	Loose or faulty cabling to the DSP Multi Axis PCBA. Loose or faulty limit switch cabling.	• Check and secure all cable connections. • Reconnect or replace any disconnected or damaged cables.
	Defective joystick.	Perform the joystick troubleshooting procedure on page 108.
	Defective DSP Multi Axis PCBA.	• Check LED DS8 (heartbeat) on the DSP Multi Axis PCBA — LED should be on (solid) or blinking. • Check LED DS7 on the DSP Multi Axis PCBA for error codes; see ***Diagnostic LED DS7 E-Stop Codes*** on page 70. • Check power supply voltages. • Replace the DSP Multi Axis PCBA if necessary; see ***Replacing the DSP Multi Axis PCBA*** on page 196.
Axis runs to a hard stop.	Loose or faulty cabling to the DSP Multi Axis PCBA.	• Check and secure all cable connections to the DSP Multi Axis PCBA. • Reconnect or replace any disconnected or damaged cables.

Symptom	Possible Causes	Possible Solutions
Axis runs to a hard stop (continued).	Defective DSP Multi Axis PCBA.	• Check LED DS8 (heartbeat) on the DSP Multi Axis PCBA — LED should be on (solid) or blinking. • Check LED DS7 on the DSP Multi Axis PCBA for error codes; see ***Diagnostic LED DS7 E-Stop Codes*** on page 70. • Check power supply voltages. • Replace the DSP Multi Axis PCBA if necessary; see ***Replacing the DSP Multi Axis PCBA*** on page 196.
	Incorrect tuning parameters.	Contact the Customer Support HelpDesk (see ***Where to Get Help*** on page 4) for more information.
Axis “runs away” at power up.	DSP Multi Axis PCBA not loaded correctly.	Reboot the metrology software.
Note: This is very rare, so contact the Customer Support HelpDesk (see ***Where to Get Help*** on page 4) and provide as much information as possible.	Loose or faulty cabling to the DSP Multi Axis PCBA.	• Check and secure all cable connections to the DSP Multi Axis PCBA. • Reconnect or replace any disconnected or damaged cables.
	Loose or faulty scale cables.	• Check and secure all scale cable connections. • Reconnect or replace any disconnected or damaged cables.
	Misaligned scale reader head.	• Check the scale reader head alignment along the full length of travel. • Re-align the scale reader head if necessary.

Symptom	Possible Causes	Possible Solutions
Axis “runs away” at power up (continued).	Defective scale reader head on the affected axis.	• Check for lost scale counts by zeroing the affected axis, moving a known distance along the axis, and comparing the reading displayed in the DRO to the nominal distance. • Check for proper scale operation by observing the corresponding diagnostic LEDs on the DSP Multi Axis PCBA as you *slowly* move along the affected axis — the LEDs should indicate quadrature (see ***Quadrature*** on page 69). • Replace the scale reader head if necessary; see ***Replacing the Scale Reader Heads*** on page 173.
	Defective DSP Multi Axis PCBA.	• Check LED DS8 (heartbeat) on the DSP Multi Axis PCBA — LED should be on (solid) or blinking. • Check LED DS7 on the DSP Multi Axis PCBA for error codes; see ***Diagnostic LED DS7 E-Stop Codes*** on page 70. • Check power supply voltages. • Replace the DSP Multi Axis PCBA if necessary; see ***Replacing the DSP Multi Axis PCBA*** on page 196
Axis exhibits squealing, knocking, or hard clicks.	Loose Z-axis hardware or damaged Z-axis ball screw.	• Power down the system. Then remove the front cover and check for loose hardware or defective ball screw. • Contact the Customer Support HelpDesk (see ***Where to Get Help*** on page 4) for more information.
	Incorrect tuning parameters or the acceleration is set too high.	Contact the Customer Support HelpDesk (see ***Where to Get Help*** on page 4) for more information.

Symptom	Possible Causes	Possible Solutions
Axis does not finish a move or hesitates when finishing a move.	Defective scale reader head on the affected axis.	• Check for lost scale counts by zeroing the affected axis, moving a known distance along the axis, and comparing the reading displayed in the DRO to the nominal distance. • Check for proper scale operation by observing the corresponding diagnostic LEDs on the DSP Multi Axis PCBA as you move *slowly* along the affected axis — the LEDs should indicate quadrature (see ***Quadrature*** on page 69). • Replace the defective scale reader head if necessary; see ***Replacing the Scale Reader Heads*** on page 173.
	Incorrect servo parameters.	Contact the Customer Support HelpDesk (see ***Where to Get Help*** on page 4) for more information.
Axis oscillates.	Loose or faulty cabling to/ from the DSP Multi Axis PCBA.	• Check and secure all cable connections to/from the DSP Multi Axis PCBA. • Reconnect or replace disconnected or damaged cables.
	Loose or defective motor on the affected axis.	Verify motor mounting hardware is secure; replace defective motor if necessary. • If the X-axis motor is defective, see ***Replacing the X-Axis Motor*** on page 185. • If the Y-axis motor is defective, see ***Replacing the Y-Axis Motor*** on page 187 • If the Z-axis motor is defective, see ***Replacing the Z-Axis Motor*** on page 190.
	Incorrect servo parameters.	Contact the Customer Support HelpDesk (see ***Where to Get Help*** on page 4) for more information.

Symptom	Possible Causes	Possible Solutions
Axis oscillates (continued).	Defective scale reader head on the affected axis.	• Check for lost scale counts by zeroing the affected axis, moving a known distance along the axis, and comparing the reading displayed in the DRO to the nominal distance. • Check for proper scale operation by observing the corresponding diagnostic LEDs on the DSP Multi Axis PCBA as you move *slowly* along the affected axis — the LEDs should indicate quadrature (see ***Quadrature*** on page 69). • Replace the defective scale reader head if necessary; see ***Replacing the Scale Reader Heads*** on page 173.
	Defective DSP Multi Axis PCBA.	• Check LED DS8 (heartbeat) on the DSP Multi Axis PCBA — LED should be on (solid) or blinking. • Check LED DS7 on the DSP Multi Axis PCBA for error codes; see ***Diagnostic LED DS7 E-Stop Codes*** on page 70. • Check power supply voltages. • Replace the DSP Multi Axis PCBA if necessary; see ***Replacing the DSP Multi Axis PCBA*** on page 196
	Incorrect tuning parameters.	Contact the Customer Support HelpDesk (see ***Where to Get Help*** on page 4) for more information.
Unexpected contact between the optics and a part on the stage.	Part programming error. Fixturing problem. Stage initialization error. Unexpected Z-axis movement.	Perform the recovery procedure on page 114.

7.8.4 Video Troubleshooting

Symptom	Possible Causes	Possible Solutions
No live video, but menus OK.	Incorrect color settings.	1. Right-click the Windows Desktop and select **Properties** from the context menu. 2. Click the **Settings** tab and make sure **Colors** is set to 24- or 32-bit.
	Loose or faulty video and/or camera cables.	• Check and secure all cable connections. • Reconnect or replace any disconnected or damaged cables.
	Corrupted registry of `.INI` files.	Copy known good files from backup disk.
	Corrupt inspection program.	Reload the program.
	Defective camera.	Replace the defective camera; see ***Replacing the High & Low Mag Cameras*** on page 167.
	Defective QVI video capture card.	Contact the Customer Support HelpDesk (see ***Where to Get Help*** on page 4) for more information.
No live video or menus.	Loose or faulty monitor cabling.	• Check and secure all cable connections. • Reconnect or replace any disconnected or damaged cables.
	Defective QVI video capture card.	Contact the Customer Support HelpDesk (see ***Where to Get Help*** on page 4) for more information.
	If the system boots up on power and cabling is not the problem, check for defective monitor.	Replace the monitor.
Live video but no stored video.	Defective QVI video capture card.	Contact the Customer Support HelpDesk (see ***Where to Get Help*** on page 4) for more information.

Symptom	Possible Causes	Possible Solutions
During focus, video image moves erratically	Environmental vibration.	Relocate system.
	Misconfigured camera.	Contact the Customer Support HelpDesk (see ***Where to Get Help*** on page 4) for more information.
	Loose Z-axis motor mounting hardware.	Power down the system. Then remove the front cover and verify the motor mounting hardware is secure.
	Defective Z-axis motor.	Replace the Z-axis motor if necessary; see ***Replacing the Z-Axis Motor*** on page 190.

7.9 Identifying Problems with the System Computer & User-Interface Components

Before you suspect a serious problem with the system computer, remember that adding hardware and/or software can affect the existing system. Recheck any installations you may have recently performed.

7.9.1 Start-Up & General Performance

Symptom	Possible Causes
Computer does not power up when you press the power switch.	• Check for loose or disconnected power cord; reconnect the power cord if necessary. • Computer BIOS not configured to power on after a power failure; contact the Customer Support HelpDesk (see ***Where to Get Help*** on page 4) for more information.
Computer is unable to download to the DSP Multi Axis PCBA during start-up.	• Check for loose or disconnected parallel cable.
Computer does not boot from disk.	• Check associated cables and verify power to the disk drive; replace drive if necessary. • Computer BIOS is not configured to boot from disk drive first; contact the Customer Support HelpDesk (see ***Where to Get Help*** on page 4) for more information.
Computer does not boot from hard drive.	• Verify that there is no disk in the disk drive. • Check for data corruption on the hard drive. • Check the power and data connections to the hard drive.
Erratic computer operation after booting.	• Check for sags in power supply voltage — measure voltages with all cards plugged in.
Computer does not read disk.	• Disk is damaged; reformat disk or try new disk. • Check cabling to disk drive; replace drive if necessary.

7.9.2 Communications

The serial ports rarely have hardware problems. Almost all problems are due to external wiring or software issues.

Symptom	Possible Causes
Serial port does not seem to operate.	• Test communications to a second CPU or terminal.
Cannot communicate on network.	• Check for appropriate software drivers. • Check cable termination and length. • Check network card/software configuration. • Check memory allocation. • Check firewall settings.

7.9.3 Joystick

Symptom	Possible Causes
No movement.	• One of the E-Stop switches has been pressed. • System is in Stop Mode; press the **Start/Stop** button on the joystick to resume normal operation. • Loose or disconnected joystick; verify joystick is properly connected to the machine. • Defective joystick; perform the joystick troubleshooting procedure on page 108. • Check stage for holding torque; stage may have faulted.
Stage moves without input.	• Centering switches on joystick are not locked. • Check the DAC test points on the DSP Multi Axis PCBA and adjust the offset potentiometers if necessary; refer to the *DSP Multi Axis Board Service Guide* (P/N 790168). • Defective joystick; perform the joystick troubleshooting procedure on page 108.

7.9.4 Troubleshooting the Joystick

Note: The following procedure only applies to systems equipped with the DSP Multi Axis PCBA (P/N 03640x, revision E or higher).

Figure 7-11 shows the test points on the DSP Multi Axis PCBA that are used to troubleshoot the joystick.

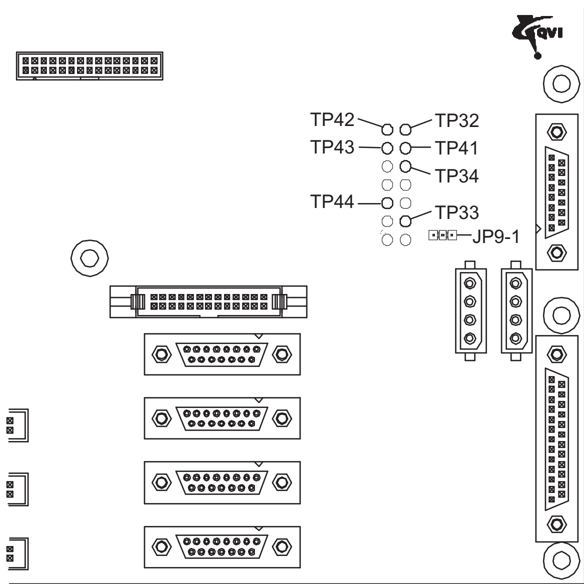


Figure 7-11 Location of the Joystick Troubleshooting Test Points on the DSP Multi Axis PCBA

7.9.4.1 Verifying VREF+ from the DSP PCBA to the Joystick

1. Connect the positive (+) lead of a Digital Volt Meter (DVM) to pin 1 on JP9 and connect the negative (-) lead to TP41. The reading (VREF+) should be **3.0VDC ±10%**.

- If the reading is within specification, the joystick, interconnecting cables, and DSP Multi Axis PCBA are all working properly; you do not have to perform the rest of this procedure.
- If the reading is not within specification, continue with the next step in this procedure.

2. Unplug the joystick and re-check VREF+. Again, the reading should be **3.0VDC ±10%**.

- If the reading is within specification, connect the joystick **directly** to the DSP Multi Axis PCBA (no interconnecting cables) and re-check VREF+.
  – If the reading is within specification, replace the interconnecting cables between the joystick and the DSP Multi Axis PCBA.
  – If the reading is not within specification, replace the joystick.
- If the reading is not within specification, check the power supply voltages to the DSP Multi Axis PCBA (+5VDC and +12VDC). If the voltages are OK, perform the next procedure. Otherwise, replace the DSP Multi Axis PCBA; see ***Replacing the DSP Multi Axis PCBA*** on page 196.

7.9.4.2 Verifying Joystick Potentiometer at Input to the DSP PCBA

1. Make sure the joystick is not deflected and use a DVM to measure the voltage between the following on the DSP Multi Axis PCBA:

- TP41 and TP32
- TP41 and TP33
- TP41 and TP34

Each reading should be (VREF+/2) ±5%.

- If the voltages are within specification, continue with the next step in this procedure.
- If the voltages are not within specification and cabling is not the problem, replace the joystick.

2. Connect the negative (-) lead of the DVM to TP41 and connect the positive (+) lead to:

- TP32 to measure the X_POT — voltage should vary from ~0VDC to VREF+ when you move the joystick lever in the X direction
- TP34 to measure the Y_POT — voltage should vary from ~0VDC to VREF+ when you move the joystick lever in the Y direction
- TP33 to measure the Z_POT — voltage should vary from ~1VDC to 2VDC when you twist the joystick knob

Move the joystick lever (XY) or twist the joystick knob (Z) to check the different input voltages. The voltages should be within the specifications listed above.

- If the voltages are within specification, perform the next procedure.
- If the voltages are not within specification and cabling is not the problem, replace the joystick.

7.9.4.3 Verifying Joystick Potentiometers at Input to A/D Converter

1. Connect the negative (-) lead of the DVM to TP41 and connect the positive (+) lead to:

- TP42 to measure the X_POT — voltage should vary from ~0VDC to VREF+ when you move the joystick lever in the X direction
- TP44 to measure the Y_POT — voltage should vary from ~0VDC to VREF+ when you move the joystick lever in the Y direction
- TP43 to measure the Z_POT — voltage should vary from ~0VDC to VREF+ when you twist the joystick knob

Move the joystick lever (XY) or twist the joystick knob (Z) to check the different input voltages. The voltages should be within the specifications listed above.

- If the potentiometer voltages are within specification, the joystick, interconnecting cables and DSP Multi Axis PCBA are all working properly.
- If the voltages are not within specification, replace the DSP Multi Axis PCBA; see ***Replacing the DSP Multi Axis PCBA*** on page 196.

7.9.5 Keyboard

Symptom	Possible Causes
No response.	• Check keyboard cabling; Replace keyboard if necessary. • Make sure system computer is powered up.
Some keys stick or do not respond.	• Clean all internal surfaces of keyboard.

Caution: Never connect or unplug the keyboard (or mouse) from the PS2 connector on the system computer while the computer is energized. Doing so could damage the motherboard in the system computer.

7.9.6 Flat Panel Display

Symptom	Possible Causes
No video.	• Make sure the flat panel display is plugged in and the power switch is in the ON position. • Check the video acquisition and memory cards for failure. • Make sure the system computer is powered up and all cables are connected properly.
No video, or high pitched squeal and no video.	• Internal circuit or high-voltage breakdown.
Color shift or image not straight.	• Degauss the monitor. • Reduce proximity to nearby magnetic field.
Noise in image or noisy (floating) image.	• Reduce proximity to nearby electric field, including a second monitor. • Screen adjustment pots could be dirty. Turn all pots several times from end to end to clean wipers.
Fixed bars or striped pattern on screen (live video window).	• Re-install `.INI` files from backup disk. • Confirm that all display settings and drivers are correct.

Symptom	Possible Causes
No live video (software running and lights on).	• See if lights are set to 0% or if lighting is too low for the part. • Check for defective camera cable.
Image appears "choppy" during stage motion.	• This is normal and can be minimized by increasing the monitor refresh frequency. 1. Right-click on the Windows desktop. 2. Select **Properties** from the context menu. 3. Click the **Settings** tab and click the **Advanced** button. 4. Click the **Monitor** tab and select a refresh frequency of 75 Hertz or higher from the **Refresh Frequency** list. (We recommend selecting the maximum refresh frequency.)
Circles appear elliptical.	• Incorrect monitor aspect ratio. Replace with a monitor that has a native aspect ratio of 4:3.

7.10 Recovering from Unexpected Z-Axis Contact

Warning: NEVER ATTEMPT TO MANUALLY MOVE THE Z-AXIS TRANSPORT BY TURNING THE BALL SCREW WITH POWER APPLIED TO THE MACHINE. Doing so could result in personal injury.

Caution: Never attempt to lift the Z-axis transport by the optics. Possible damage to the equipment could occur.

Note: It is not necessary to remove the optics cover in order to recover from unexpected Z-axis contact.

1. Press the **Stop/Start** button on the joystick.
2. Twist the joystick knob clockwise to raise the Z-axis transport.

Note: The system may re-enter E-Stop immediately after you twist the joystick knob, which indicates that the Z-axis transport has separated mechanically from the Z-axis ball screw.

3. Repeat Steps 1 and 2 until the Z-axis clears the obstruction.
4. Once the Z-axis is clear, remove the obstruction from the stage area.
5. Twist the joystick knob clockwise to raise the Z-axis transport to the upper limit of travel to clear the error message displayed on the screen.

If you are unable to return the system to normal operation by performing the procedure outlined above, perform the following procedure to manually turn the Z-axis ball screw and reseat the Z-axis drive bracket onto the Z-axis drive nut.

1. Press the remote E-Stop switch.

Warning: Make sure the system is in E-Stop before performing the next step; the Stop LED on the right-hand side of the machine should be blinking rapidly.

2. Remove the front cover by lifting it straight up off its guides. Set the cover aside.

3. Insert a large, flat-head screwdriver into the slot in the top of the Z-axis ball screw.

Note: The Z-axis ball screw is slotted so a flat-head screwdriver can be used to turn it. However, the Z-axis electric brake will be engaged, which may make it difficult to turn the Z-axis ball screw.

4. Once the Z-axis is clear, remove the obstruction from the stage area.

5. Reset the remote E-Stop switch by twisting the knob in the direction of the arrows.

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

7. Twist the joystick knob clockwise to raise the Z-axis transport to the upper limit of travel to clear the software message displayed on the screen.

This page has been left intentionally blank.

Service Adjustments

Chapter 8

8.1 What This Chapter Contains

This chapter covers how to calibrate and align the optics.

Warning: The risk of electrical shock is present anytime the covers are removed from the machine. To avoid exposure to high voltage, never remove the covers from the monitor or system power supplies.

Caution: Protect the Benchmark 450 system from electrostatic damage by performing these procedures at a static-safe workstation and wearing a ground strap. If a ground strap is not available, follow these guidelines:

- Work in an uncarpeted area.
- Discharge static electricity before touching electronic components by touching a known-grounded object.
- Do not touch components on printed circuit boards, except as directed.

8.2 Benchmark 450 Service Adjustments

The following is a list of service adjustments that should be performed on the Benchmark 450 system if components are repaired or replaced.

Service Adjustment	Purpose	Where to Find Procedure
Integrated Workstation Adjustment (If Equipped)	Perform to adjust the workstation to the preferred height and rotation	See ***Integrated Workstation Adjustment (If Equipped)*** on page 119.
Dual Magnification Optical System Adjustments	Perform whenever a critical component within the optical path has been removed and/or replaced	See ***Dual Magnification Optical System Adjustments*** on page 120.
Lens Calibration	Perform to calibrate the field of view for the magnification lens that is currently installed on the system	See ***Lens Calibration*** on page 141.
AccuCentric Assembly Alignment (If Equipped)	Perform whenever the AccuCentric assembly or optical system is replaced	See ***AccuCentric Assembly Alignment (If Equipped)*** on page 143.
LED Programmable Ring Light (PRL) Adjustments (If Equipped)	Perform after Z certification or installation of a new PRL to ensure proper light output and concentricity within the system optics	See ***LED Programmable Ring Light (PRL) Adjustments (If Equipped)*** on page 146.

8.3 Integrated Workstation Adjustment (If Equipped)

The integrated workstation can be adjusted to your preferred height and rotation, and can be adjusted to accommodate either a standing or a sitting position.

Height Adjustment:

1. Loosen the locking knob located on the mount.

2. Adjust the workstation to the desired height.

3. Tighten the locking knob.

Rotation Adjustment:

1. Loosen the locking knob located under the monitor/keyboard tray.

2. Rotate the tray to the desired rotation.

3. Tighten the locking knob.

8.4 Dual Magnification Optical System Adjustments

The dual magnification optical system uses two monochrome cameras on two separate optical paths to provide instant magnification switching under software control. A third optical path is included to provide coaxial (through the lens) illumination and a (Ronchi) grid pattern for autofocus. This section outlines the procedures for on-system alignment of the dual magnification optical system.

8.4.1 Component Location

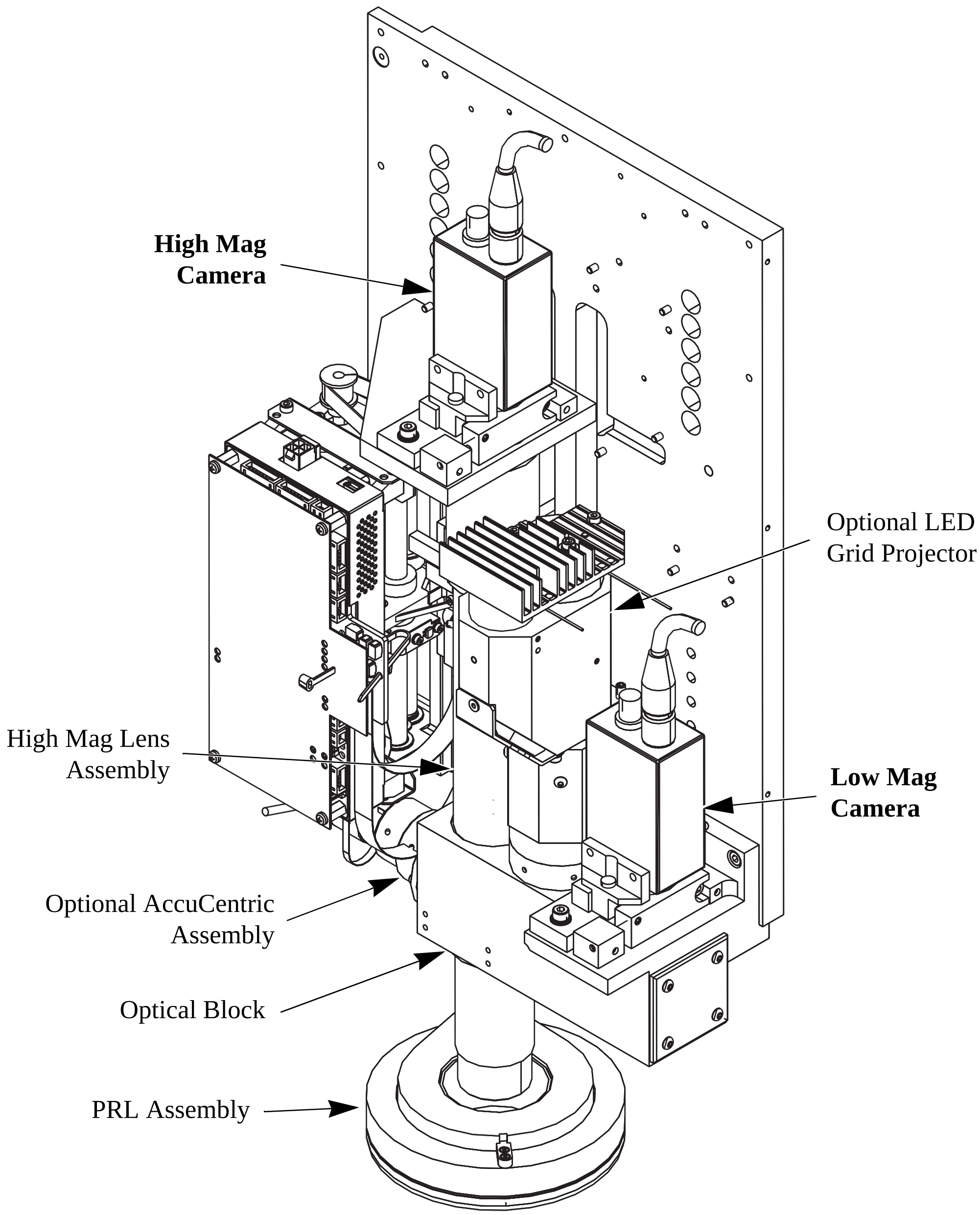


Figure 8-1 Optical Components (shown with optional LED grid projector)

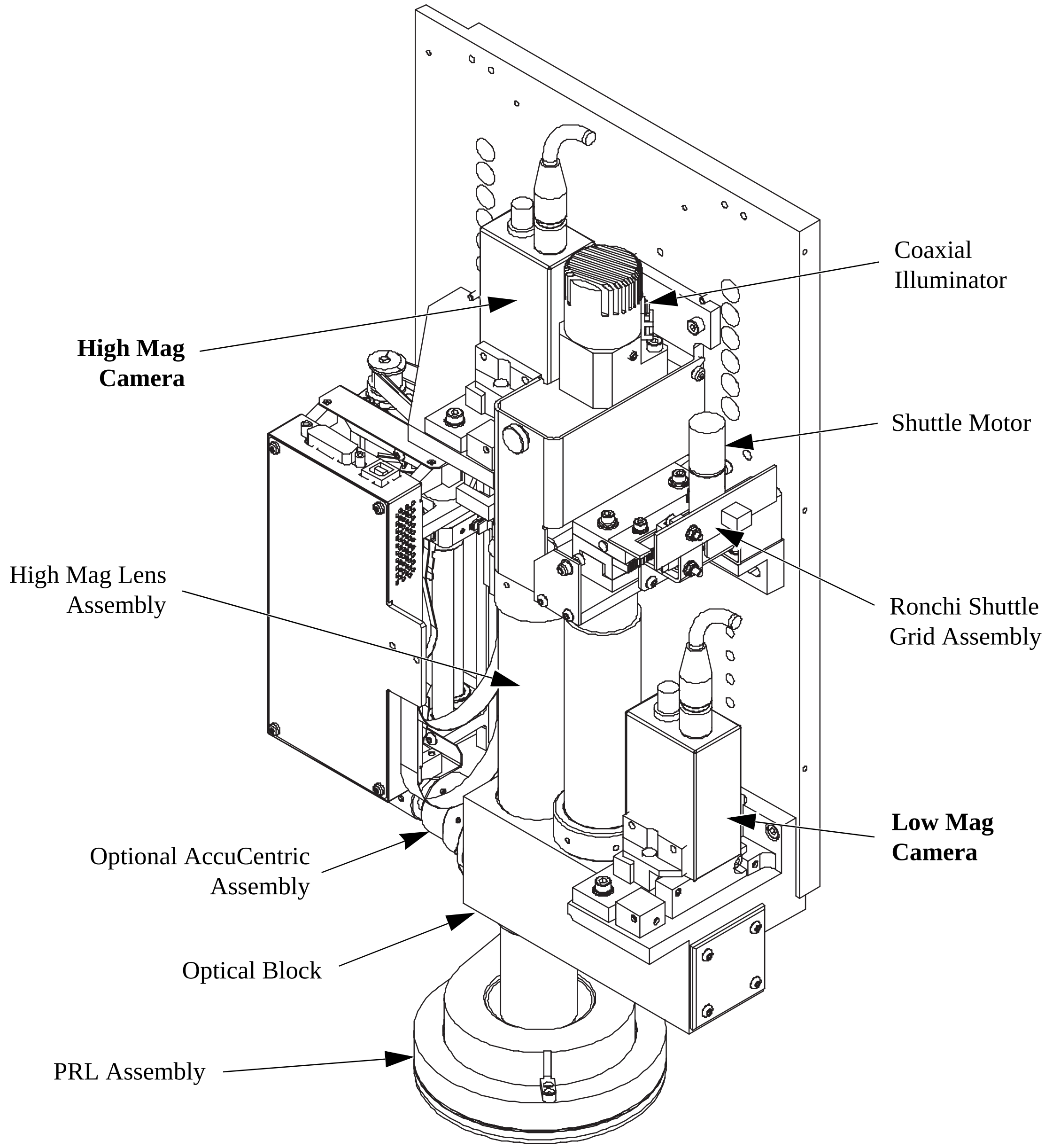


Figure 8-2 Optical Components (shown with optional Ronchi Shuttle grid assembly)

8.4.2 Sequence of Optical Adjustments

The following list summarizes the optical system adjustments and the order in which they should be performed.

Optical Adjustment	Purpose	Where to Find Procedure
Coaxial Illuminator and Shuttle Window Position *(procedure only applies to systems equipped with Ronchi Shuttle grid option)*	Aligns the coaxial illuminator and Ronchi shuttle so there are no shadows in the field of view	See ***Ronchi Shuttle Window Position Adjustment (If Equipped)*** on page 123.
Shuttle Opto Switch Flag and End Limits *(procedure only applies to systems equipped with Ronchi Shuttle grid option)*	Ensures that each grid covers the entire field of view when selected	See ***Ronchi Shuttle Opto Switch Flag & End Limits Adjustment (If Equipped)*** on page 124.
Ronchi Grid Rotation *(procedure only applies to systems equipped with Ronchi Shuttle grid option)*	Ensures that each grid is square to the field of view	See ***Ronchi Grid Rotation Adjustment (If Equipped)*** on page 126.
Camera Parfocal	Adjusts camera(s) so the part image stays in focus when switching from High to Low Mag, and vice versa	See ***Camera Parfocal Adjustment*** on page 127 or ***Camera Parfocal Adjustment (Systems Equipped with Ronchi Grid)*** on page 130
LED Grid Projector Focus *(procedure only applies to systems equipped with LED grid projector option)*	Adjusts the focus of the grid image.	See ***LED Grid Projector Focus Adjustment (If Equipped)*** on page 134.
Camera Par-Center (Coaxial)	Aligns the optical axis of each camera to the optical axis of the lens	See ***Camera Par-Center (Coaxial) Adjustment*** on page 136.
Camera Rotation	Ensures that each camera is square to the X and Y axes	See ***Camera Rotation Adjustment*** on page 139.

Note: The various optical system adjustments are interrelated. Adjustments, no matter how minor, to one component may affect the alignment of other components. Repeat all adjustment procedures until there are no visible offsets.

8.4.3 Ronchi Shuttle Window Position Adjustment (If Equipped)

Warning: Adjusting the Ronchi shuttle requires you to perform adjustments on powered components. When the shuttle is powered up, be careful where you place your fingers, and do not allow anyone to move the shuttle (or even use an Autofocus Finder) or access the shuttle electronics or cabling while a person's fingers are near the shuttle.

Tools Required	Part No.
1X magnification lens	638939
Set of Metric Allen wrenches	N/A
Set of English Allen wrenches	N/A
Small Phillips-head screwdriver	N/A
Mirror	N/A

1. Use a 1X magnification lens, the Low Mag camera, and coaxial illumination to focus manually on a mirror (dust or scratches help). If necessary, manually position the Ronchi shuttle so the grids are not visible in the field of view.

2. Inspect the image to see if the Ronchi shuttle is blocking the light on the left or right sides. If it is, loosen the two shuttle mounting screws, and slide it horizontally to a position where it does not block the coaxial illumination. Make sure the shuttle assembly vertically touches the two locating pins that keep it at a calibrated Z position. Lock down the shuttle mounting screws when finished.

3. Inspect the Low Mag camera image for dark corners (vignetting). (This will be more evident when using a 2/3" camera in the Low Mag optical path.)

   - If the corners are dark, they should at least be equally dark in all four corners.

   - If the corners are not dark, adjust the XY position of the coaxial illuminator by unscrewing the upper and lower halves and repositioning the assembly. If this does not work, either the video cameras are not on the optical centerline (see ***Camera Par-Center (Coaxial) Adjustment*** on page 136) or there is an internal problem in the optical block assembly, in which case you should contact the Customer Support HelpDesk (see ***Where to Get Help*** on page 4) for more information.

8.4.4 Ronchi Shuttle Opto Switch Flag & End Limits Adjustment (If Equipped)

Tools Required	Part No.
1X magnification lens	638939
Set of Metric Allen wrenches	N/A
Set of English Allen wrenches	N/A
Small Phillips-head screwdriver	N/A
Mirror	N/A

1. Use a 1X magnification lens, the Low Mag camera, and coaxial illumination to focus manually on a mirror again. Then manually position the Ronchi shuttle so the Low Mag grid is visible in the image.
2. Adjust the Low Mag end limit set screw on the Ronchi shuttle so the diagonal Ronchi grid pattern covers the entire video image without any obstruction when the shuttle contacts the Z back plate.
3. Check to make sure that the Ronchi shuttle opto switch is connected to the Ronchi shuttle controller cable. If opto switch is not connected, press the remote E-Stop switch, connect it, and then reset the E-Stop condition. **Do not connect the Ronchi shuttle motor yet.**
4. Move the shuttle in and out of the Low Mag grid position. The red light on the opto switch should turn off when the shuttle is within 3 to 4 mm of touching the end limit. If it does not, adjust the opto switch flag.
5. Press the remote E-Stop switch and connect the motor. Reset the E-Stop switch by twisting the knob in the direction of the arrows. Then press the **Stop/Start** button on the joystick and look at the shuttle. The shuttle should move quickly to the Low Mag grid position, sense the opto switch, and then move to the center position.

6. Look at the Low Mag camera image in the Video window, and check to see if either grid is partially visible at the top or bottom of the screen. Gently push the shuttle back and forth within its center position *dead band*. If you can see either grid starting to enter the Video window, adjust the shuttle flag position; see Figure 8-3.

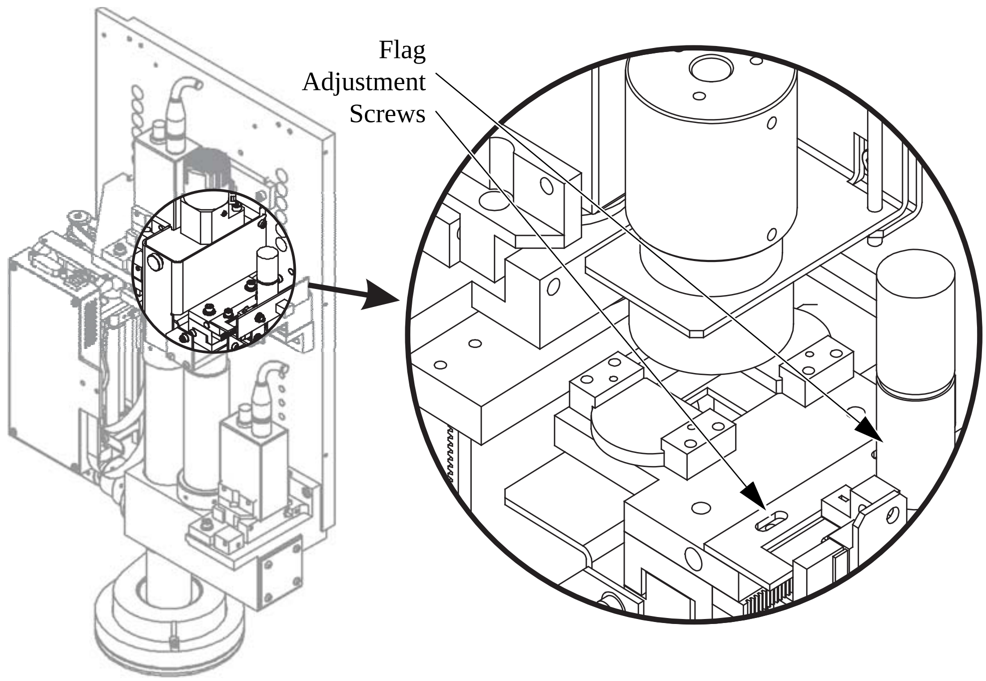
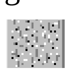


Figure 8-3 Flag Adjustment

7. To adjust the flag position, press the remote E-Stop switch and move the flag.

8. When finished, reset the E-Stop switch by twisting the knob in the direction of the arrows, and then press the **Stop/Start** button on the joystick. The shuttle will re-zero itself. (The shuttle only reacts to the new flag position after moving to the Low Mag grid position, which it does automatically when it powers up.)

9. Click  in the VMS Video window and click  in the Autofocus Settings window. Verify that the grid is displayed properly.

10. Click  and verify that there are no obstructions in the image from the Ronchi shuttle.

11. Switch to the High Mag camera, and click . The shuttle should move to the High Mag position. (You may need to move in Z to manually focus the grid image.) Adjust the High Mag grid end travel limit so it lightly touches the shuttle as it comes to a stop. When done, there should be a 3 to 4 mm dead band.

8.4.5 Ronchi Grid Rotation Adjustment (If Equipped)

Tools Required	Part No.
Set of Metric Allen wrenches	N/A
Set of English Allen wrenches	N/A

1. Remove the grid dust cover so you can visually check the rotation of the High and Low Mag grids (see Figure 8-4). Both grids should be square to the X-axis.

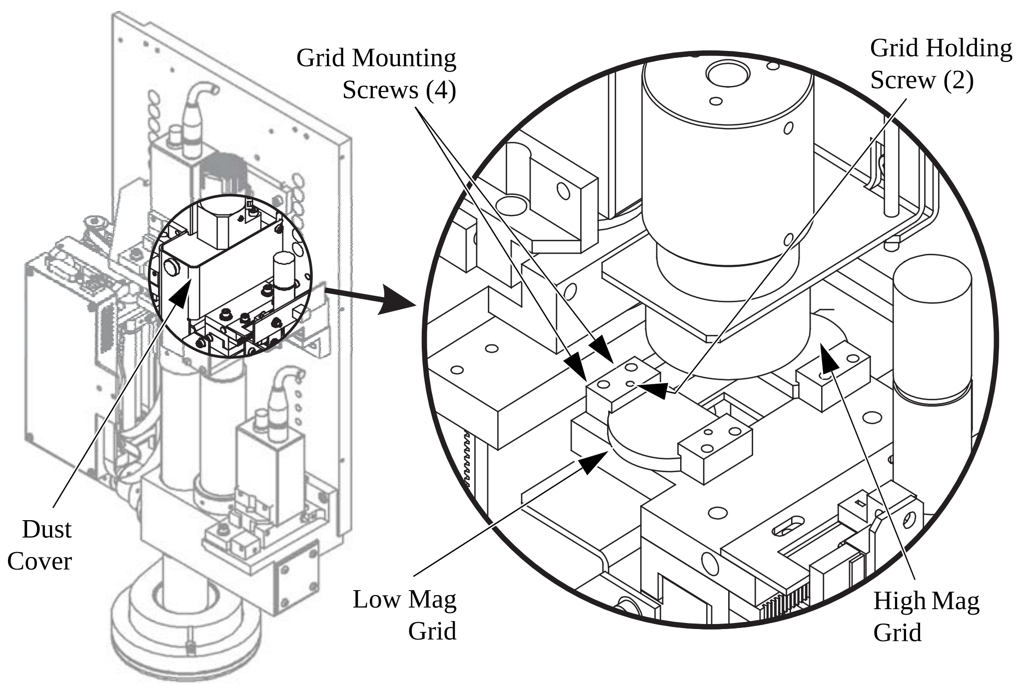


Figure 8-4 Ronchi Grid Rotation Adjustment

2. If either grid is not square, loosen the mounting screws for that grid and adjust the rotation of the grid. When the grid is square, carefully tighten the grid mounting screws.

3. Re-install the dust cover.

8.4.6 Camera Parfocal Adjustment

Note: Camera parfocal affects camera centering and camera rotation; repeat all adjustment procedures until there are no visible offsets.

Tools Required	Part No.
1X magnification lens	638939
QVI Alignment Reticle	623970
Set of Metric Allen wrenches	N/A
Set of English Allen wrenches	N/A
Small Phillips-head screwdriver	N/A

1. Place and secure the QVI Alignment reticle on the stage glass.
2. Install a 1X magnification lens and select the Low Mag camera.
3. Select **Setup / Calibration** in the VMS main menu to display the Lens Calibrations window (see Figure 8-5).

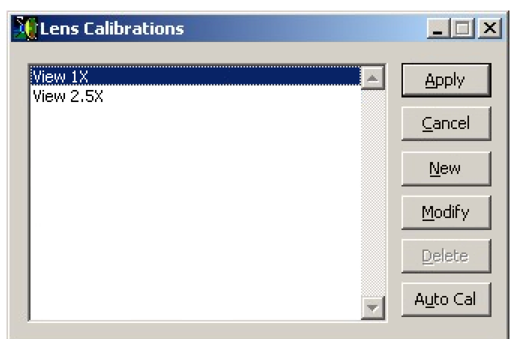


Figure 8-5 Lens Calibrations Window

4. From the list, select the 1X magnification lens.

5. Click **Modify** to display the Define Lens Calibration window (see Figure 8-6).

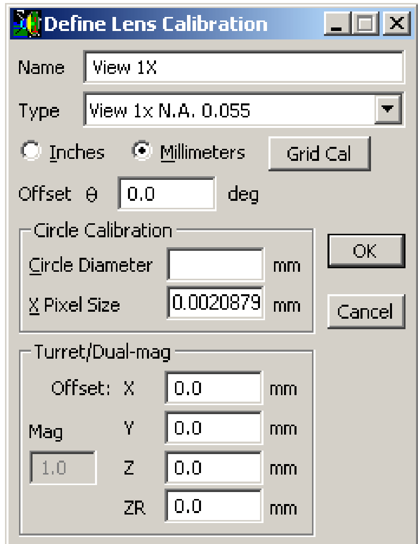


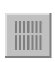
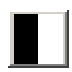
Figure 8-6 Define Lens Calibration Window

6. Zero the Θ, **X**, **Y**, and **Z** offsets, and then click **OK**.

7. Click **Apply** in the Lens Calibrations window and close the window.

8. Select the High Mag camera.

9. Repeat Steps 3 through 7 to zero the Θ, **X**, **Y**, and **Z** offsets at High Mag.

10. Click  in the Video window toolbar and click  in the Autofocus Settings window to select the Edge Focus tool.

11. Perform an autofocus on the right edge of the reticle square using backlight illumination (no coaxial illumination).

12. Right-click in the DRO window and select **Zero DRO** in the context menu to zero the DRO.

13. Select the Low Mag camera; adjust the illumination if necessary.

14. Perform an autofocus on the right edge of the reticle square. The Z change in the DRO should be zero or very close to zero.

    If the change is more than **0.010 mm (0.0004")**, continue with the next step. Otherwise, stop here; no adjustment is required.

15. Loosen the Low Mag camera clamp and adjust the focus set screw shown in Figure 8-7. Re-tighten the camera clamp when finished.

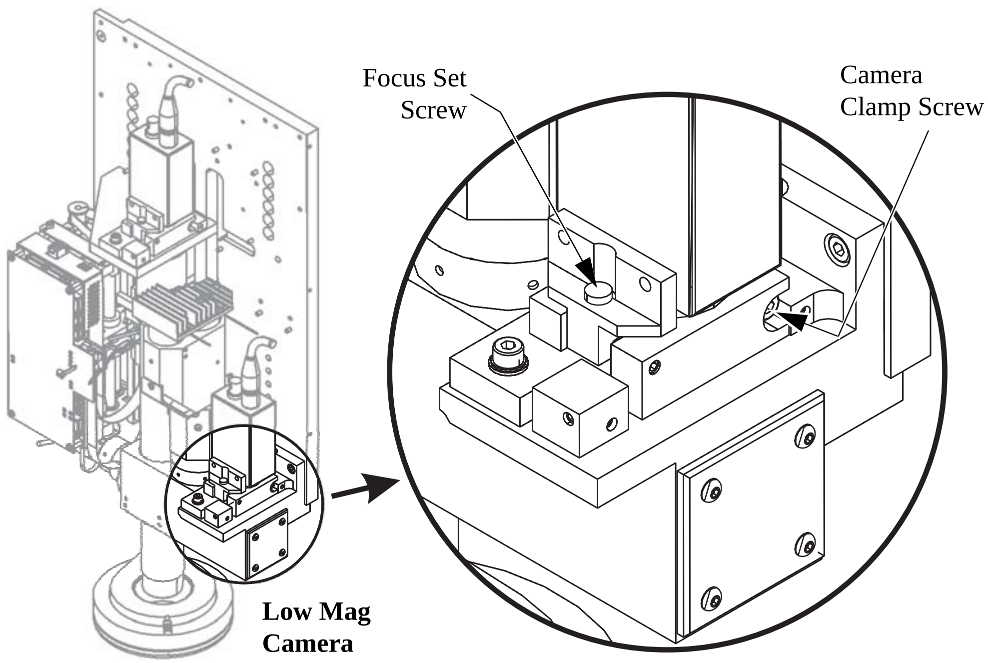


Figure 8-7 Low Mag Camera Focus Adjustment

16. Repeat Steps 8 through 15 until the High Mag-to-Low Mag focus comparison is within specification.

8.4.7 Camera Parfocal Adjustment (Systems Equipped with Ronchi Grid)

Note: Camera parfocal affects camera centering and camera rotation; repeat all adjustment procedures until there are no visible offsets.

Note: This section only applies to systems equipped with the optional Ronchi grid.

Tools Required	Part No.
1X magnification lens	638939
QVI Alignment Reticle	623970
Set of Metric Allen wrenches	N/A
Set of English Allen wrenches	N/A
Small Phillips-head screwdriver	N/A

1. Install a 1X magnification lens.
2. Place and secure the QVI Alignment Reticle on the stage glass.
3. Select the Low Mag camera.
4. Select **Setup / Calibration** in the VMS main menu to display the Lens Calibrations window (see Figure 8-8).

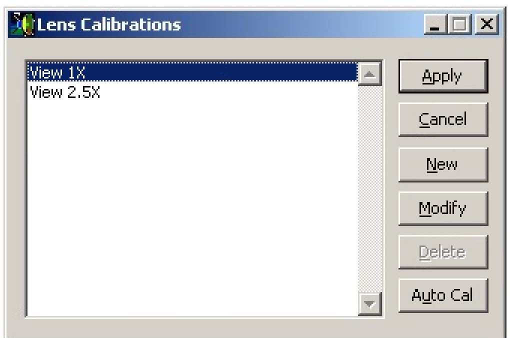


Figure 8-8 Lens Calibrations Window

5. From the list, select the magnification lens that is currently installed (for example, “View 1X”).

6. Click **Modify** to display the Define Lens Calibration window (see Figure 8-9).

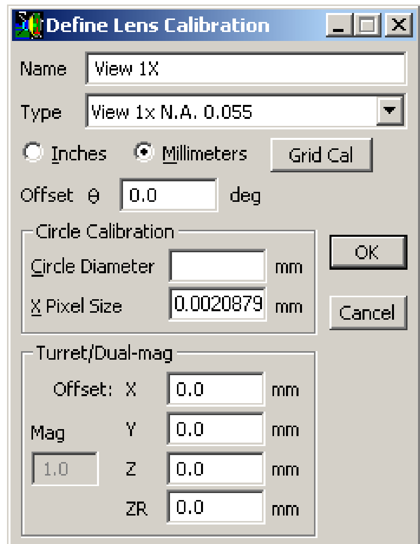


Figure 8-9 Define Lens Calibration Window

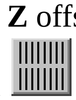
7. Zero the Θ, **X**, **Y**, and **Z** offsets, and then click **OK**.

8. Click **Apply** in the Lens Calibrations window and close the window.

Ronchi Grid-to-Surface Parfocal

9. Select the High Mag camera.

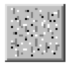
10. Repeat Steps 4 through 8 to zero the Θ, **X**, **Y**, and **Z** offsets at High Mag.

11. Click  in the Video window toolbar and click  in the Autofocus Settings window to select the Grid Focus tool (grid pattern appears in the video window); adjust the illumination if necessary.

12. Access the VMS Stage and Lights window, and use the Backlight slider to increase the intensity of backlight illumination.

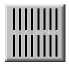
13. Perform an autofocus on the upper-right corner of the reticle square.

14. Right-click in the DRO window and select **Zero DRO** in the context menu to zero the DRO.

15. Click  in the Autofocus Settings window to select the Textured Surface Focus tool (no grid).

16. Perform another autofocus on the reticle. The Z change in the DRO should be zero or very close to zero.

If the change is more than **0.010 mm (0.0004")**, continue with the next step. Otherwise, go to Step 19.

17. Click  to select the Grid Focus tool and adjust the focus of the High Mag camera until the best focus is achieved — loosen the camera clamp and adjust the focus set screw shown in Figure 8-10. Re-tighten the camera clamp when finished. If necessary, find the two focus settings where the image goes out of focus and set the focus adjustment midway between them.

Note: The camera clamp screw for the High Mag camera is on the left side and it is a left-hand thread screw; i.e., turn clockwise to loosen, counterclockwise to tighten.

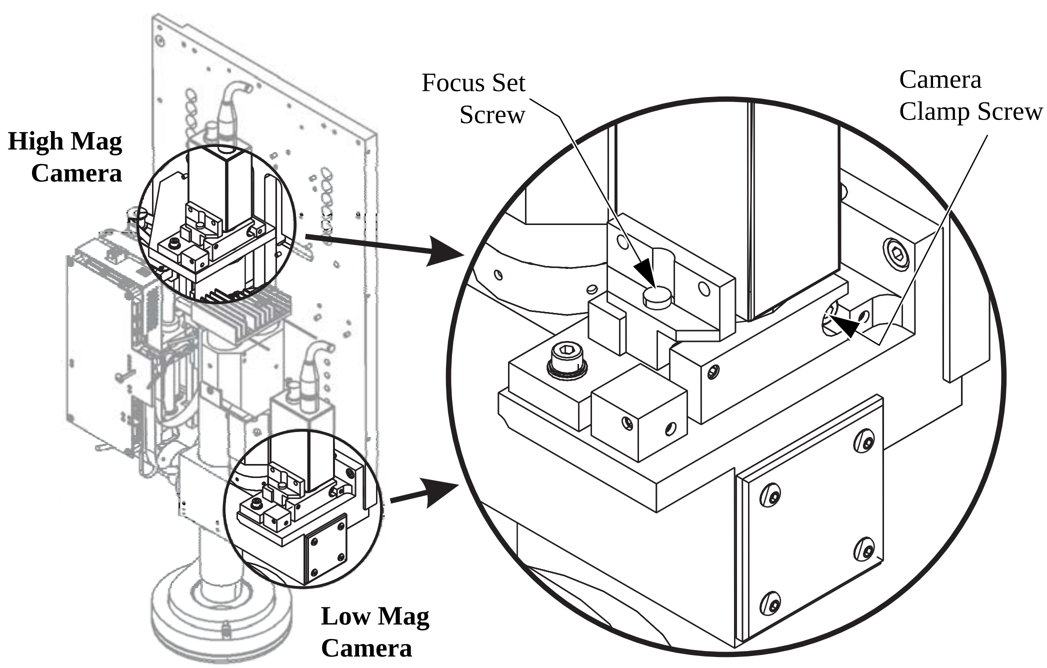


Figure 8-10 Camera Focus Adjustment

18. Repeat Steps 11 through 17 until the Grid-to-Surface focus comparison is within specification.

High-to-Low Mag Parfocal

19. Zero the DRO and select the Low Mag camera. Then use the Textured Surface Focus tool to perform an autofocus on the reticle. The Z change in the DRO should be zero or very close to zero.

If the change is more than **0.010 mm (0.0004")**, continue with the next step. Otherwise, no adjustment is required; go to Step 23.

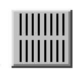
20. Adjust the focus of the Low Mag camera until the best focus is achieved — loosen the camera clamp, and adjust the focus set screw shown in Figure 8-10. Re-tighten the camera clamp screw when finished.

21. Select the High Mag camera and perform an autofocus on the reticle.

22. Repeat Steps 19 through 21 until the High Mag-to-Low Mag focus comparison is within specification.

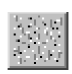
Ronchi Grid-to-Surface Parfocal (Fine Tuning)

23. Select the High Mag camera.

24. Click  in the Video window toolbar and click  in the Autofocus Settings window to select the Grid Focus tool (grid pattern appears in the Video window); adjust the illumination if necessary.

25. Perform an autofocus on the upper-right corner of the reticle square.

26. Right-click in the DRO window and select **Zero DRO** in the context menu to zero the DRO.

27. Click  in the Autofocus Settings window to select the Textured Surface Focus tool (no grid). Perform another autofocus on the reticle.

28. Note the Z change in the DRO, which should be zero or very close to zero.

29. Select **Setup / Calibration** in the VMS main menu to display the Lens Calibrations window (seeFigure 8-8 on page 130).

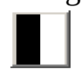
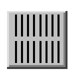
30. From the list, select the lens that is currently installed (for example, “View 1X”). Then click **Modify** to display the Define Lens Calibration window (see Figure 8-9 on page 131).

31. Type the value from Step 28 into the **ZR** offset box and click **OK**. Then click **Apply** in the Lens Calibrations window and close the window.

8.4.8 LED Grid Projector Focus Adjustment (If Equipped)

Note: This section only applies to systems equipped with the optional LED grid projector.

Tools Required	Part No.
1X magnification lens	638939
Set of Metric Allen wrenches	N/A
QVI Alignment Reticle	623970

1. Place and secure the QVI Alignment reticle on the stage glass.
2. Install a 1X magnification lens and select the High Mag camera.
3. Click  in the Video window toolbar and click  in the Autofocus Settings window to select the Edge Focus tool.
4. Perform an autofocus on the right edge of the reticle square using backlight illumination (no coaxial illumination).
5. Right-click in the DRO window and select **Zero DRO** in the context menu to zero the DRO.
6. Adjust the backlight illumination to 0% and increase the coaxial illumination.
7. Click  in the Autofocus Settings window to select the Grid Focus tool (grid pattern appears in the video window); adjust the illumination if necessary.
8. Perform an autofocus on the **glass surface next to the reticle square**. The Z change in the DRO should be zero or very close to zero.

   If the change is more than **0.010 mm (0.0004")**, continue with the next step. Otherwise, stop here; no adjustment is required.

9. Adjust the focus of the grid projector — loosen the grid projector lock-down screws and adjust the grid projector focus screw shown in Figure 8-11. Re-tighten the lock-down screws when finished.

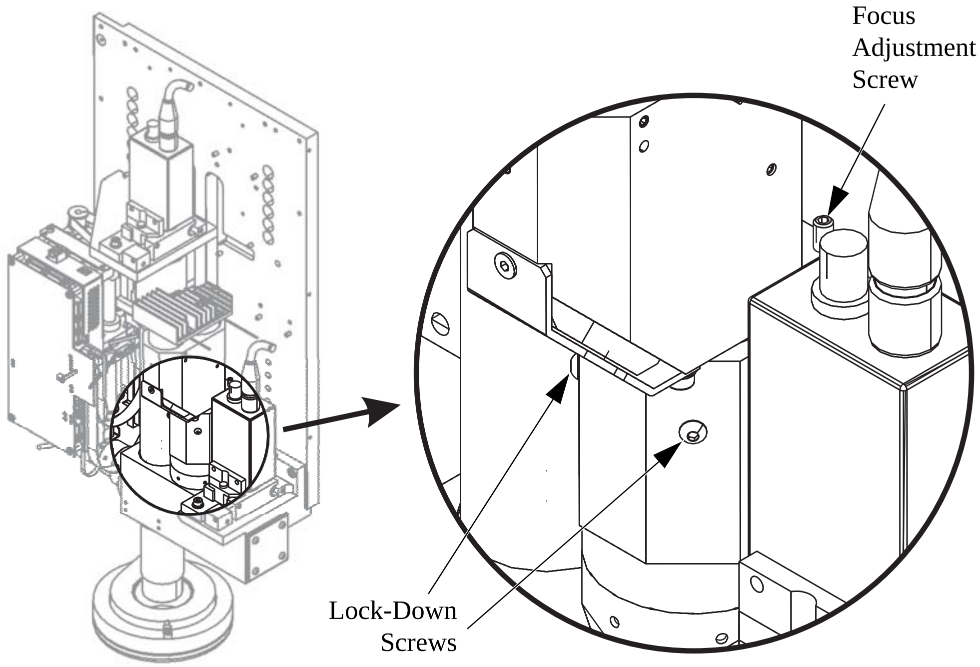


Figure 8-11 Grid Projector Focus Adjustment

10. Repeat Steps 3 through 9 until the High Mag-to-Grid focus comparison is within specification.

8.4.9 Camera Par-Center (Coaxial) Adjustment

Note: Camera centering affects camera rotation and camera parfocal; repeat all adjustment procedures until there are no visible offsets.

Tools Required	Part No.
1X magnification lens	638939
50X magnification lens (see note)	N/A
QVI Alignment Reticle	623970
Set of Metric Allen wrenches	N/A
Set of English Allen wrenches	N/A
Small Phillips-head screwdriver	N/A

Note: For the best results, we recommend using a 50X magnification lens. If a 50X magnification lens is not available, you can:

- Use the highest available magnification lens.
- Contact the Customer Support HelpDesk to arrange for an on-site service call.
- Contact the Customer Support HelpDesk to obtain a 50X magnification lens.

Par-Center Between Lenses

1. Place and secure the QVI Alignment Reticle on the stage glass.
2. Install a 50X magnification lens and select the High Mag camera.
3. Focus on the upper-right corner of the reticle square using backlight illumination.
4. Click  to display the Crosshair Finder. Make sure the finder is at the “X = 0, Y = 0” location, and then use XY stage motion to align the upper-right corner of the reticle square to the Crosshair Finder.
5. Without moving the QVI Alignment Reticle or worktable, very carefully remove the 50X magnification lens and install the 1X magnification lens.

   Observe whether or not the upper-right corner of the reticle square is still aligned to the Crosshair Finder, within **±0.005 mm (±0.0002")**. If the corner is no longer aligned, continue with the next step. Otherwise, go to Step 8.

6. Loosen the High Mag camera position lock-down screws and adjust the X and Y direction set screws (see Figure 8-12) until the upper-right corner of the reticle square is aligned to the Crosshair Finder, within **±0.005 mm (±0.0002")**. Make sure the finder is at the “X = 0, Y = 0” location.

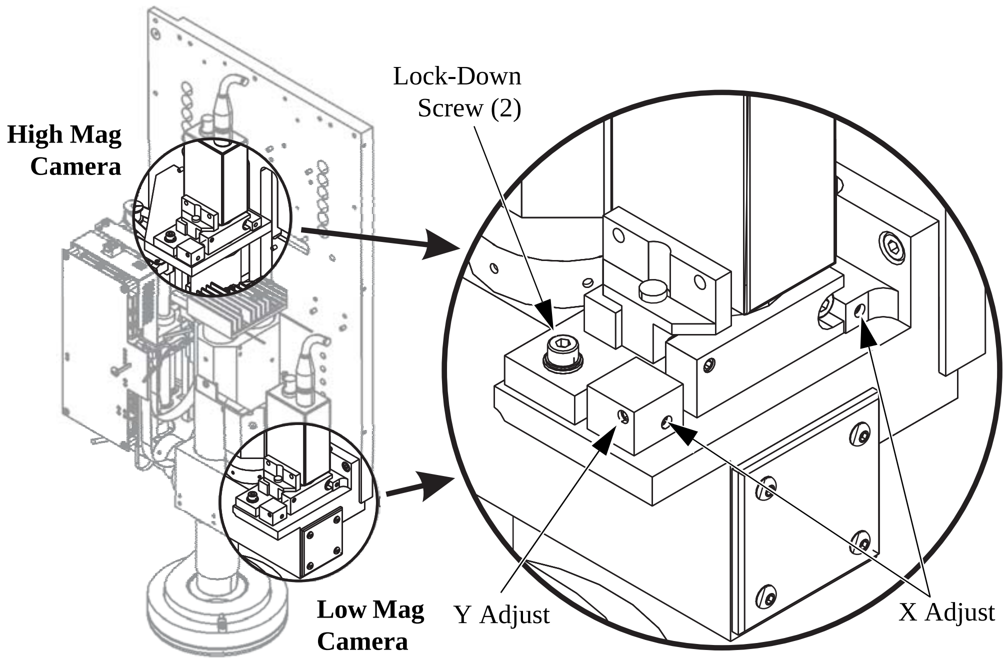


Figure 8-12 Camera Par-Center Adjustment

7. Repeat Steps 2 through 6 until the upper-right corner of the reticle square remains aligned to the Crosshair Finder (without moving the QVI Alignment Reticle or worktable) when you switch from the 50X magnification lens to the 1X magnification lens, and vice versa. Make sure the High Mag camera lock-down screws are fully tightened when finished.

Par-Center Between Cameras

8. With the 1X magnification lens installed and the QVI Alignment Reticle in the same location as in the previous steps, select the High Mag camera and use XY stage motion to align the upper-right corner of the reticle square to the Crosshair Finder. Make sure the center of the finder is at the “X = 0, Y = 0” location.

9. Without moving the QVI Alignment Reticle or worktable, switch to the Low Mag camera and observe whether or not the upper-right corner of the reticle square is aligned to the Crosshair Finder, within **±0.005 mm (±0.0002")**.

- If the corner is no longer aligned to the Crosshair Finder, continue with the next step.
- If the corner remains aligned, no adjustment is required and you do not have to perform the rest of this procedure (check the rotational alignment of each camera; see ***Camera Rotation Adjustment*** on page 139).

10. Loosen the Low Mag camera position lock-down screws, and adjust the X and Y direction set screws (see Figure 8-12) until the upper-right corner of the reticle square is aligned to the Crosshair Finder, within **±0.005 mm (±0.0002")**. Make sure the center of the finder is at the “X = 0, Y = 0” location.

11. Repeat Steps 8 through 10 until the upper-right corner of the reticle square remains aligned to the Crosshair Finder (without moving the QVI Alignment Reticle or worktable) when you switch from High Mag to Low Mag, and vice versa. Make sure the Low Mag camera lock-down screws are fully tightened when finished.

12. Check the rotational alignment of each camera; see ***Camera Rotation Adjustment*** on page 139.

8.4.10 Camera Rotation Adjustment

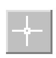
Note: Camera rotation affects camera centering and camera parfocal; repeat all adjustment procedures until there are no visible offsets.

Tools Required	Part No.
1X magnification lens	638939
Chrome-on-glass linear scale (longer than the X length of travel)	N/A
Set of Metric Allen wrenches	N/A
Set of English Allen wrenches	N/A
Small Phillips-head screwdriver	N/A

1. Place a chrome-on-glass linear scale that is longer than the X length of travel on the worktable, parallel to the X-axis.

2. Install a 1X magnification lens and select the High Mag camera.

3. Focus on the scale using coaxial illumination. (Do not use backlight illumination.)

4. Click  in the Video Window toolbar to display the Crosshair Finder.

5. Adjust (tram in) the rotation of scale until the observed vertical movement in the Video window is less than **0.005 mm (0.0002")** when the X-axis stage is driven over the entire length of X travel.

6. After the glass scale has been trammed in, use the joystick to drive the X-axis stage over the full length of X travel while observing the image of the scale.

If the image of the glass scale appears to move vertically more than **0.005 mm (0.0002")**, continue with the next step. Otherwise, go to Step 8.

7. Loosen the High Mag camera clamp screw and adjust the rotation set screws (see Figure 8-13) until the observed vertical movement between the Crosshair Finder and the scale is less than **0.005 mm (0.0002")** when the X-axis stage is driven over the entire length of X travel. Tighten the camera clamp when finished.

Note: The camera clamp screw for the High Mag camera is a left-hand thread screw; i.e., turn clockwise to loosen, counterclockwise to tighten.

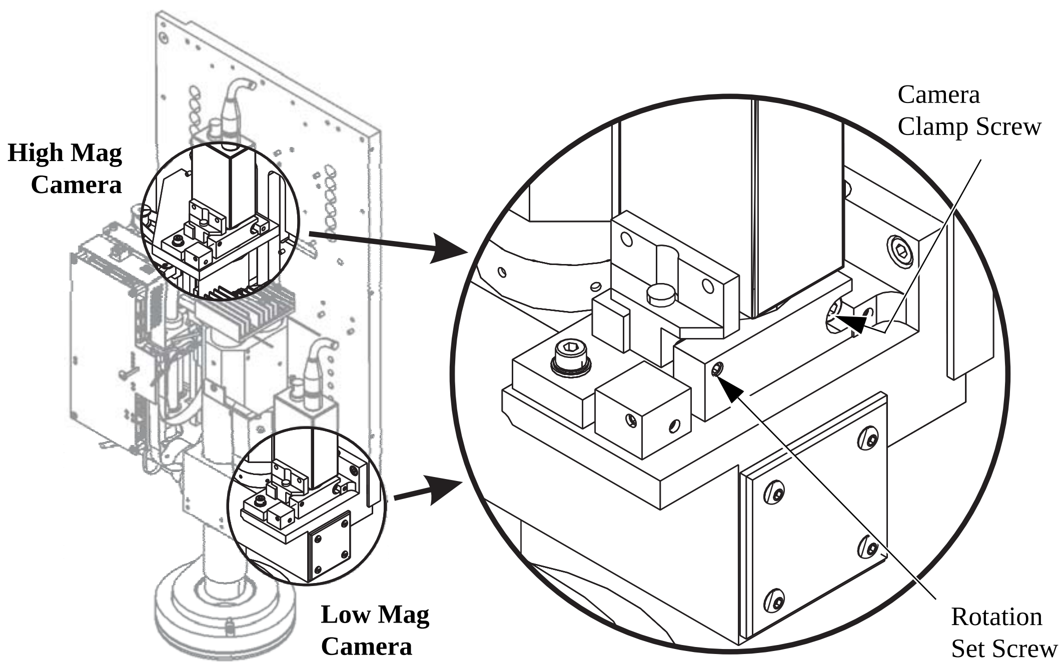


Figure 8-13 Camera Rotation Adjustment

8. Without moving the glass scale, select the Low Mag camera. Then use the joystick to drive the X-axis stage over the entire length of X travel while observing the image of the scale.

If the image of the scale appears to move vertically more than **0.005 mm (0.0002")**, continue with the next step. If the observed vertical movement is less than **0.005 mm (0.0002")**, go to Step 10.

9. Loosen the Low Mag camera clamp screw and adjust the rotation set screws until the observed vertical movement between the Crosshair Finder and the scale is less than **0.005 mm (0.0002")** when the X-axis stage is driven over the entire length of X travel. Tighten the camera clamp when finished.

10. Check the par-center (coaxial) alignment of each video camera; see ***Camera Par-Center (Coaxial) Adjustment*** on page 136.

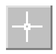
8.5 Lens Calibration

Tools Required	Part No.
QVI Alignment Reticle	623970

Note: Make sure the optics are aligned before performing this procedure.

1. Install the magnification lens that you want to calibrate; see ***Replacing the Magnification Lens*** on page 166.

2. Mount and secure the QVI Alignment Reticle on the stage glass, so the lower-left corner of the reticle square is in the field of view.

3. Click  in the Video Window toolbar to display the Crosshair Finder.

4. Adjust (tram in) the rotation of the reticle so it is square to the field of view.

5. Select the High Mag camera and manually focus the lower-left corner of the reticle square.

6. Select **Setup / Calibration** in the VMS main menu to display the Lens Calibrations window (see Figure 8-14).

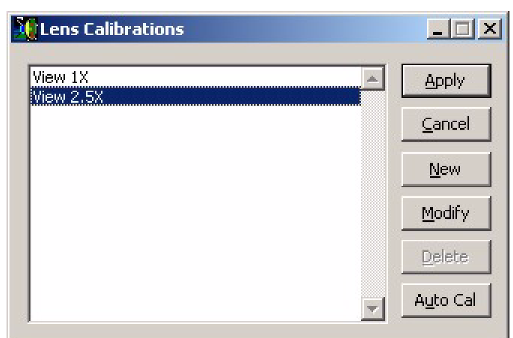


Figure 8-14 Lens Calibrations Window

7. From the list, select the magnification lens that is currently installed on the system.

Note: If the lens you want to calibrate is not listed in the Lens Calibrations window, click **New** and define the new lens by selecting the type of lens and entering a descriptive name for the lens (for example, View 1X).

8. Click **Auto Cal** to display the FOV Calibration window (see Figure 8-15).

Figure 8-15 FOV Calibration Window

9. Select the **No Square Pixel** radio button.

10. Click **Start** and then click **OK** in response to the displayed prompt.

    The system automatically performs the lens calibration and displays the FOV Calibration window (see Figure 8-15) when finished.

11. Click **Close** to close the FOV Calibration window.

12. In the Lens Calibrations window (see Figure 8-14), click **Apply** to apply the changes.

13. Click **Close** to close the Lens Calibrations window.

8.6 AccuCentric Assembly Alignment (If Equipped)

Note: This section only applies to systems equipped with the optional AccuCentric assembly.

Tools Required	Part No.
Set of Metric Allen wrenches	N/A

Note: The AccuCentric assembly inserts a reticle image into the optical path that can be used to recalibrate the optical system whenever you switch from High Mag to Low Mag, and vice versa.

1. Launch the VMS software.

2. Click **Zero Stage** in the Stage and Lights window to zero the stages.

3. Switch to the High Mag camera and adjust all lights levels to 0%.

4. Increase the intensity of the AccuCentric LED as much as possible without saturating the camera. The bright spot in the Video window that occupies most of the field of view is the image of the LED reticle.

- If the reticle image is *not* in focus, continue with Step 5 to make the required adjustment.
- If the reticle image is in focus, go to Step 9.

5. Remove the front cover by lifting it straight up off its guides.

6. Use a 1.5 mm Allen wrench to loosen the set screws that secure the reticle housing in place (see Figure 8-16).

7. Slide the reticle housing in/out until the reticle image is in focus in the Video window.

8. Hold the reticle housing in place as you re-tighten the set screws.

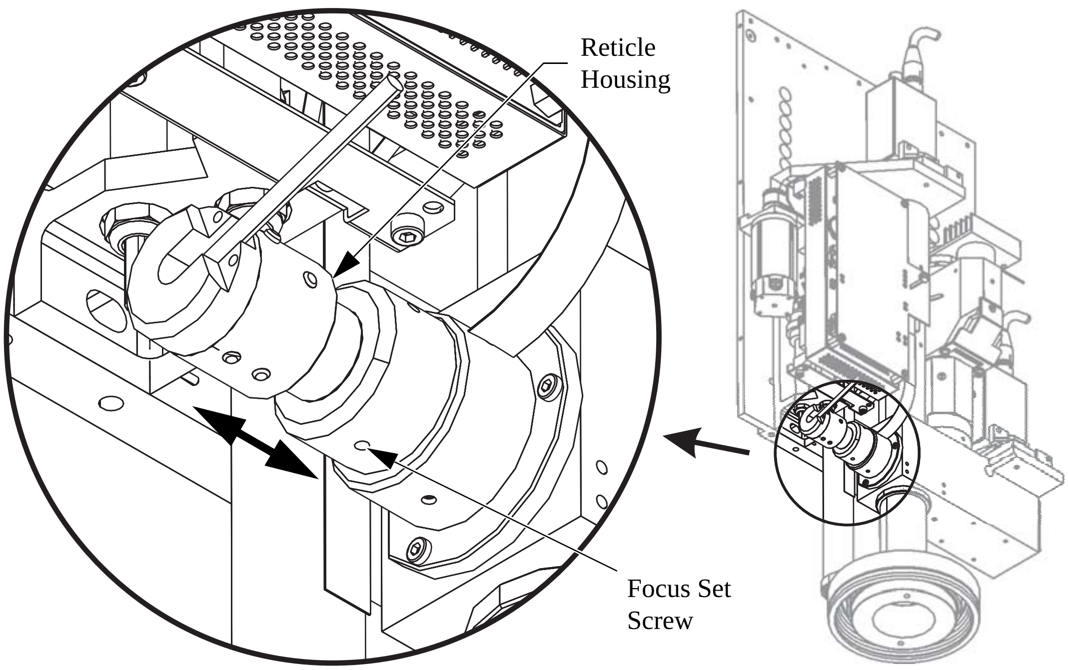
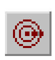


Figure 8-16 Focusing the LED Reticle

9. Click  in the Video Window toolbar to select the Circle Finder.

- If the reticle image is *not* centered within the Circle Finder, continue with Step 10 to make the required adjustment.
- If the reticle image is centered, go to Step 12.

10. If you have not already done so, remove the front cover by lifting it straight up off its guides.

11. Use a 1.5 mm Allen wrench to adjust the two centering set screws in the reticle housing (see Figure 8-17) until the reticle image is centered within the Circle Finder.

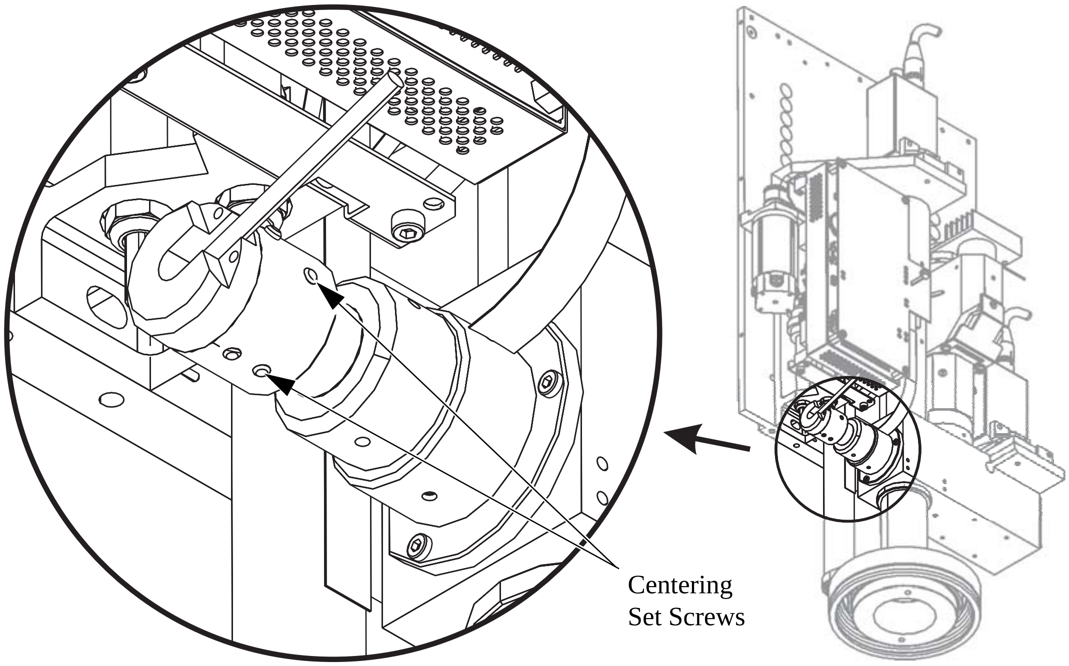


Figure 8-17 Centering the LED Reticle

12. Switch to the Low Mag camera and verify that the LED reticle image is centered within the Circle Finder at Low Mag.

- If the reticle image is *not* centered, perform the mechanical adjustment outlined in Step 11.
- If the reticle image is centered, continue with Step 13.

13. Re-install the front cover (if it was removed).

8.7 LED Programmable Ring Light (PRL) Adjustments (If Equipped)

Note: This section only applies to systems equipped with the PRL.

Tools Required	Part No.
Set of Metric Allen wrenches	N/A
Set of English Allen wrenches	N/A
1X magnification lens	638939
Small, flat-head screwdriver	N/A
ViewDiag software (rev 2.01 or higher)	N/A
`LIGHTTEST70.VOY` part program	N/A
3 1/2-inch floppy disk	N/A
Gage blocks (at least 2 inches long)	N/A
Light Calibration Diffuser Block	3461257-1
1/8-inch thick plate (optional)	N/A

Note: Be sure to perform the PRL adjustment procedures outlined in this section in the order presented.

8.7.1 Centering the PRL

1. Power down the system and disconnect the power cord from the power source.
2. Manually, drive the PRL down so the mirrors stop at their lower limit.

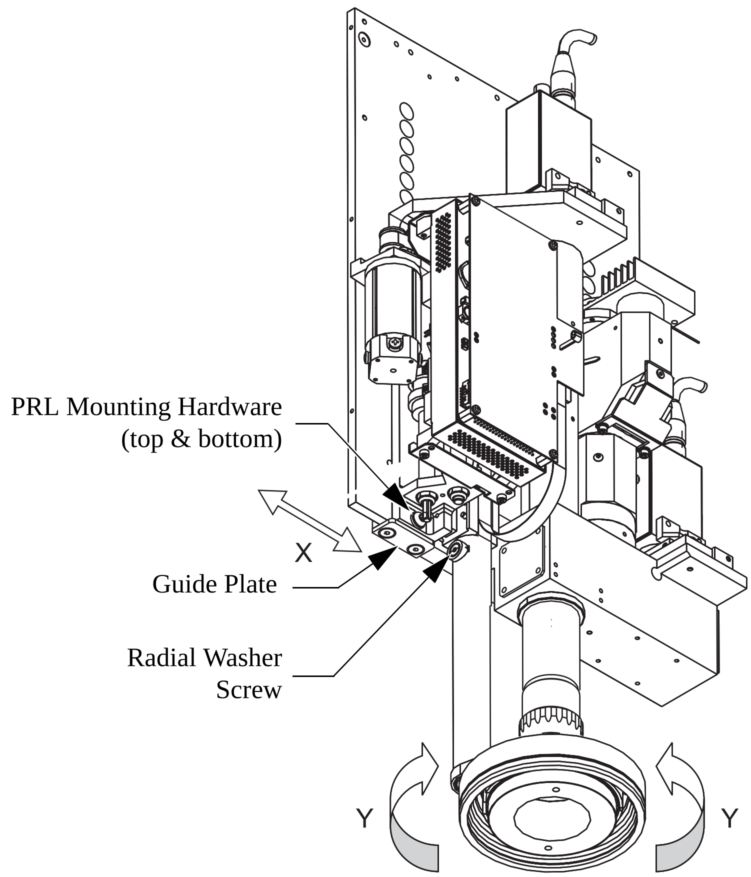


Figure 8-18 Centering the PRL

3. Loosen (do not remove) the PRL mounting screws.
4. Loosen the radial washer screw and then slightly re-tighten it so it is snug.
5. Manually drive the PRL up, so the mirrors are above the end of the lens tube (up travel). Pivot the mirror assembly as required.
6. Install a calibrated 1X magnification lens.
7. Manually drive the PRL up/down so the inner ring is approximately centered on the larger diameter (grip ridges) of the lens cover (down travel).

8. Adjust the PRL in the X and Y directions until the inner ring is approximately centered around the magnification lens.

- **To set the X direction:** Move the PRL base left or right, keeping the bottom edge of the base against the guide plate. Check for squareness by placing gage blocks under the mirrors (see Figure 8-19). Adjust as necessary.

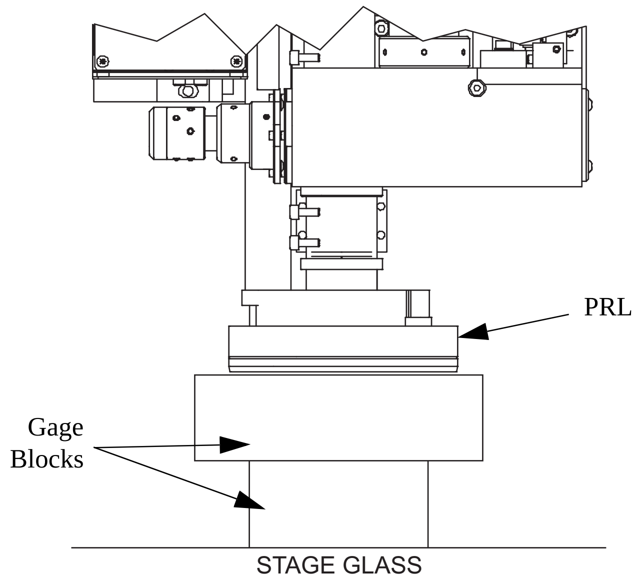


Figure 8-19 Checking for Squareness

- **To set the Y direction:** Rotate the inner ring (the outer ring will follow). Make sure the drive clamp does not come off the upper drive block. If it does, loosen the clamp screw and rotate the tab until it engages the drive block. Then re-tighten the clamp screw (see Figure 8-20).

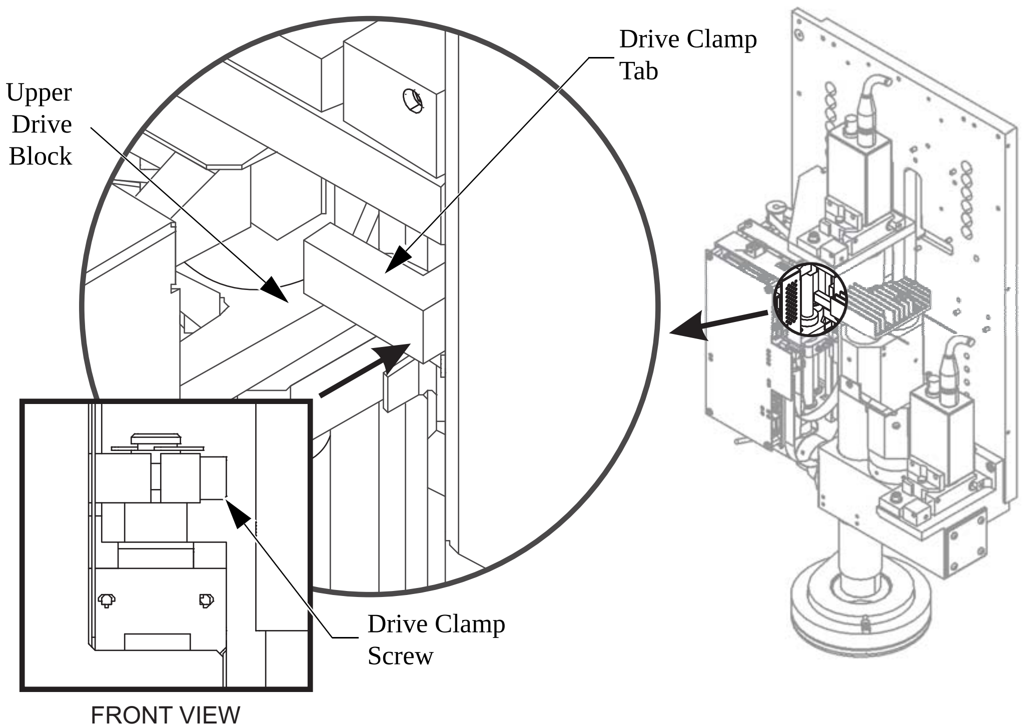


Figure 8-20 Upper Drive Block, Drive Clamp Tab, and Clamp Screw

9. After centering the inner ring, tighten all adjusting hardware. (You will need to manually drive the PRL down to access the radial washer screw.)

8.7.2 Adjusting the PRL Height

Note: This procedure sets the absolute height of the PRL rings relative to the inspection surface.

1. Power up the system.

2. Launch the VMS software.

3. Click **Zero Stage** in the Stage and Lights window to zero the stages.

4. Wait for the stages to stop moving and then use the joystick to drive the Z-axis stage to its upper limit of travel.

5. Close the VMS software and launch the ViewDiag software.

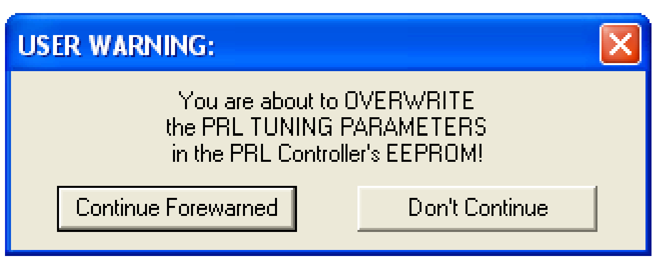
Caution: In the next step, the PRL will travel to its upper limit of travel and could make contact with the Z-axis assembly if the Z-axis stage is not at the upper limit of travel. Performing Step 4 is critical to avoiding contact.

6. Click  in the toolbar and turn on Motion Enable by clicking the **On** button.

7. Click **Calibrate Limit Switches**.

   The PRL automatically calculates its upper and lower software limits.

8. After the PRL finishes calculating its upper and lower limits, click **Save to EPROM** and then click **Continued Forewarned** in response to the following warning:



9. If necessary, select the **Pos 1** or **Pos 2** radio button to re-display the Position slider. Then use the slider to drive the PRL to its upper limit of travel.

10. Close the ViewDiag software and launch the VMS software.

11. Click **Zero Stage** in the Stage and Lights window to zero the stages.

12. Wait for the stages to stop moving and then increase the intensity of the coaxial light.

13. Use the following reference target to align the PRL to the optics. Photocopy the target and place the copy on the stage glass. Secure it to the stage glass to prevent the target from moving during the alignment.

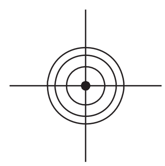
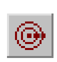


Figure 8-21 PRL to Optics Reference Target

14. Use the joystick to manually focus on and center the reference target within the field of view.

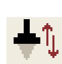
15. Right-click in the Video window and perform an Autofocus (no Ronchi). Click **OK**.

16. Click  in the Video Window toolbar to select the Circle Finder. Then verify that the optics are focused and the reference target is centered in the field of view. If necessary, focus the optics and center the target.

Note: After focusing the optics and centering the reference target, do not move the reference target or worktable for any reason.

---

17. Close the VMS software and launch the ViewDiag software.

18. Click  in the toolbar and turn on Motion Enable by clicking the **On** button.

19. Use the **Position** slider to drive the PRL to its lower limit.

20. Place a 1/8-inch thick plate (or 3 1/2-inch floppy disk) on the stage glass, below the optics.

21. Adjust the margin of the bottom switch to lower the PRL assembly so the mirrors are resting LIGHTLY on the 1/8-inch thick plate (or floppy disk); see Figure 8-22. This ensures that the mirrors are approximately 1/8-inch above the focal plane.

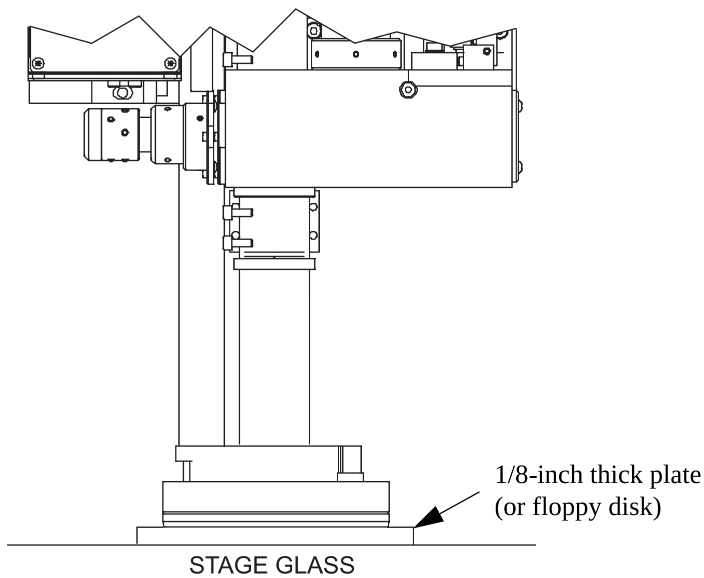
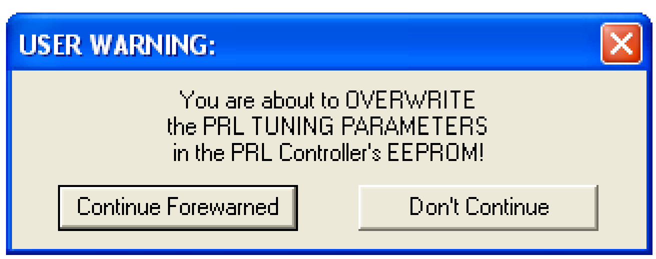


Figure 8-22 Height Adjustment

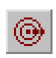
22. Click **Save to EPROM** and then click **Continued Forewarned** in response to the following warning:



23. Use the **Position** slider to drive the PRL to its upper limit and then turn off Enable Motion by clicking the **Off** button.

8.7.3 Setting Up the PRL Lights

Note: If you are performing this procedure immediately after the previous procedure and the worktable and reference target have not been moved, skip Steps 1 through 9.

1. Launch the VMS software.
2. Click **Zero Stage** in the VMS Stage and Lights window to zero the stages.
3. Wait for the stages to stop moving, and then use the Coax Light slider in the VMS Stage and Lights window to increase the intensity of coaxial illumination.
4. Photocopy the PRL reference target (see Figure 8-21 on page 151) and secure the target to the glass so it will not move during the alignment.
5. Use the joystick to manually focus and center the reference target within the field of view.
6. Right-click in the Video window and perform an Autofocus (no Ronchi).
7. Click **OK**.
8. Click  in the Video Window toolbar to select the Circle Finder. Then verify that the optics are focused and the reference target is centered in the field of view. If necessary, focus the optics and center the target.

Note: After focusing the optics and centering the reference target, do not move the reference target or worktable for any reason.

9. Close the VMS software and launch the ViewDiag software.
10. Click  in the toolbar and turn off Motion Enable by clicking the **Off** button.
11. Disconnect the PRL motor cable from the PRL Controller PCBA.

12. Manually drive the PRL down, so a 3 1/2-inch disk fits between the optical block and the top of the inner PRL ring housing (see Figure 8-23). Turn the motor shaft so the disk is firmly held in place.

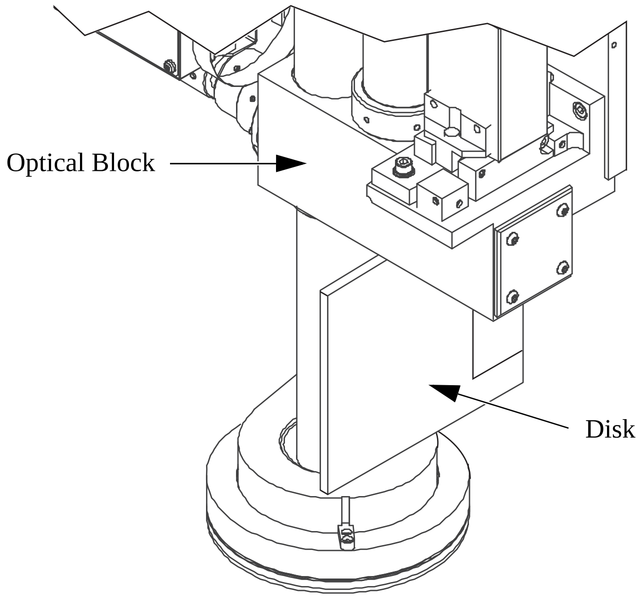


Figure 8-23 Inserting a Disk Between Optical Block and PRL

13. In the ViewDiag software, click  in the toolbar to display the Light Control window.

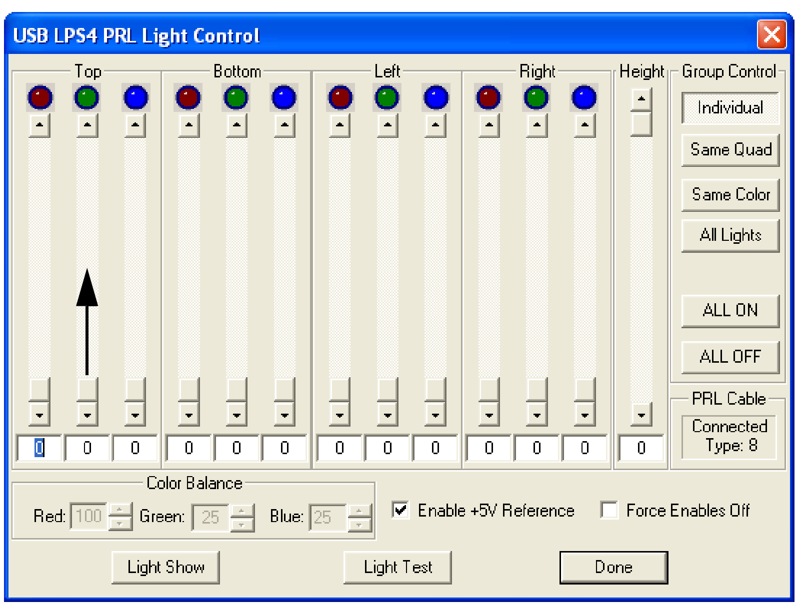


Figure 8-24 Light Control Window

14. Click **Individual** and turn on (about half way) one of the LED arrays (any color) in the **Top** quadrant (see Figure 8-24).

15. Loosen the PRL motor mount and belt tension screws.

Caution: Do not release tension on the rear shaft; this shaft is responsible for securing the floppy disk in place.

16. Without releasing the tension on the rear shaft, rotate the PRL motor to loosen the drive belt. Then manually rotate the front shaft (which controls the outer ring) up and down, observing where the light concentration “sweeps” across the reference target. The “sweet spot” should cover an 8 mm diameter, with the margins covering a diameter of 10 mm.

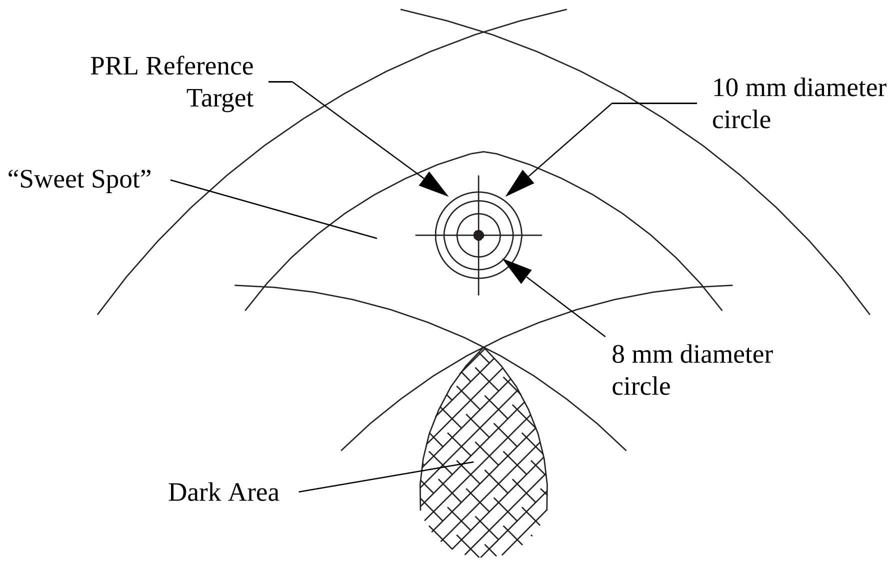


Figure 8-25 Finding the PRL’s “Sweet Spot”

17. After finding the PRL's "sweet spot," rotate the PRL motor assembly to re-tighten the drive belt. Tighten the motor mount and tension screws. (It is acceptable for the outer ring's pulley to slip into an adjacent notch on the drive belt.)

18. Manually drive the PRL assembly down so you can remove the floppy disk.

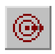
19. Separately, check all of the LED arrays (colors) in all four quadrants. If the relationship between the target diameters and the "sweet spot" of the current LED array appears out of sync, you may have to re-center the mirrors around the lens tube; see ***Centering the PRL*** on page 147.

20. Close the ViewDiag software.

21. Reconnect the PRL motor cable to the PRL Controller PCBA. (The PRL should not move when you reconnect the motor cable because you disabled motion in Step 10 above.)

22. Run the light test part program, as described next.

8.7.4 Checking the PRL Light Setup with the Light Test Part Program

1. Launch the VMS software.
2. Click **Zero Stage** in the VMS Stage and Lights window to zero the stages.
3. If necessary, secure the copy of the PRL reference target (seeFigure 8-21 on page 151) to the stage glass.
4. Use the joystick to manually focus on and center the reference target within the field of view.
5. Right-click in the Video window and perform an Autofocus (no Ronchi).
6. Click **OK**.
7. Click  in the Video Window toolbar to select the Circle Finder. Then verify that the optics are focused and the reference target is centered in the field of view. If necessary, focus the optics and center the target
8. Lower the PRL to its lower limit. The mirrors should be 1/8-inch above the stage glass (the thickness of a 3 1/2-inch disk).
   - If the height is correct, continue with the next step in this procedure.
   - If the height is incorrect, perform Steps 17 through 23 in the procedure, ***Adjusting the PRL Height*** on page 150. Then go back to the beginning of this procedure.
9. Remove the PRL reference target from the stage glass and replace it with the Light Calibration Diffuser Block (P/N 3461257-1).
10. Click  in the VMS toolbar and open the `LIGHTTEST70.VOY` part program.
11. Click  in the VMS toolbar and type the appropriate header information in the displayed User Input window.
12. In the next User Input window, type **B**.
13. In the final User Input window, type **P**.

    The part program automatically runs and checks the PRL light setup.

This page has been left intentionally blank.

Parts Repair & Replacement

Chapter 9

9.1 What This Chapter Contains

This chapter describes how to replace the Benchmark 450 imaging, transport, and electrical components. Contact your local Sales or Service Representative for part ordering information.

Warning: Unless instructed otherwise, always power down the machine and disconnect the power cord from the power source while servicing the machine; see ***System AC Power Connector*** on page 12.

Note: The risk of electrical shock is present anytime the covers are removed from the machine. To avoid exposure to high voltage, never remove the covers from the monitor or system power supplies.

Caution: Protect the Benchmark 450 system from electrostatic damage. Perform these procedures at a static-safe workstation and wear a ground strap. If a ground strap is not available, follow these guidelines:

- Work in an uncarpeted area.
- Discharge static electricity before handling electronic components by touching a known-grounded object.
- Do not touch components on printed circuit boards, except as directed.

9.2 Repairing & Replacing Parts on Your System

The following is a list of user-serviceable parts. Contact the Customer Support HelpDesk (see ***Where to Get Help*** on page 4) for the latest part revisions.

Parts to Replace	Part No.	Where to Find Procedure
Joystick, 3-axis, 2-button	039037	—
Mouse	3481204-1	—
Keyboard	3481284-1	—
Remote E-Stop	039836	—
20-inch Flat Panel LCD Monitor	037982	—
Magnification Lens, 0.8X	638685	See ***Replacing the Magnification Lens*** on page 166.
Magnification Lens, 1.0X	638939	
Magnification Lens, 2.5X	638940	
Magnification Lens, 5.0X	638941	
Magnification Lens, 10X	638942	
Magnification Lens, 25X	532186	
Camera, Low Mag, 1/2"	036473 (std) 036474 (opt)	See ***Replacing the High & Low Mag Cameras*** on page 167.
Camera, High Mag, 1/2"	036473	
PRL Assembly (if equipped)	532023	See ***Replacing the Programmable Ring Light (PRL) (If Equipped)*** on page 169.
AccuCentric Assembly (if equipped)	529650	See ***Replacing the AccuCentric Assembly (If Equipped)*** on page 171.
Scale Reader Head, X-Axis	036797 (0.5 µm) 036791 (0.1 µm)	See ***Replacing the X-Axis Scale Reader Head*** on page 174.

Parts to Replace	Part No.	Where to Find Procedure
Scale Reader Head, Y-Axis	036797 (0.5 µm) 036791 (0.1 µm)	See ***Replacing the Y-Axis Scale Reader Head*** on page 178.
Scale Reader Head, Z-Axis	039090	See ***Replacing the Z-Axis Glass Scale and Reader Head*** on page 181.
Motor, X-axis	030270	See ***Replacing the X-Axis Motor*** on page 185.
Motor, Y-Axis	030270	See ***Replacing the Y-Axis Motor*** on page 187.
Motor, Z-Axis	030270	See ***Replacing the Z-Axis Motor*** on page 190.
PCBA, DSP Multi Axis	036503.01	See ***Replacing the DSP Multi Axis PCBA*** on page 196.
PCBA, Z Brake Control	028181.11	See ***Replacing the Z Brake Control PCBA*** on page 198.
PCBA, LED Driver	039322.02	See ***Replacing the LED Driver PCBA*** on page 200.
PCBA, Dual Mag Optics	034702.01	See ***Replacing the Dual Mag Optics PCBA*** on page 202.
PCBA, Universal Multi-Sensor	032881	See ***Replacing the Universal Multisensor PCBA (If Equipped)*** on page 204.
PCBA, Micro Theta Control	039192	See ***Replacing the Micro Theta Control PCBA (If Equipped)*** on page 206.
Power Supply, 24V	036353	See ***Replacing the 24 Volt Power Supply*** on page 209.
Power Supply, 48V	026736	See ***Replacing the 48 Volt Power Supply*** on page 212.
Power Supply, ATX	032123	See ***Replacing the ATX Power Supply*** on page 215.
Fan, Electronics Exhaust	020350	See ***Replacing the Exhaust Fan*** on page 219.
Fan, Electronics Intake	020350	See ***Replacing the Intake Fan*** on page 221.

9.3 Removing the Benchmark 450 Covers

This section describes how to remove the following:

- Front cover and Z-axis cover
- Rear bridge cover
- Lower bridge cover
- Electronics enclosure panel

9.3.1 Removing the Front Cover and Z-Axis Cover

To remove the front cover:

1. Shut down the system and disconnect the power cord from the power source.

2. Lift the front cover straight up off its guides.

To remove the Z-axis cover:

1. Remove the front cover.

2. Disconnect the cable connected to the indicator LED PCBA.

3. Use a 2.5 mm Allen wrench to remove the screws that secure the Z-axis cover in place.

4. Carefully remove the Z-axis cover and set it aside.

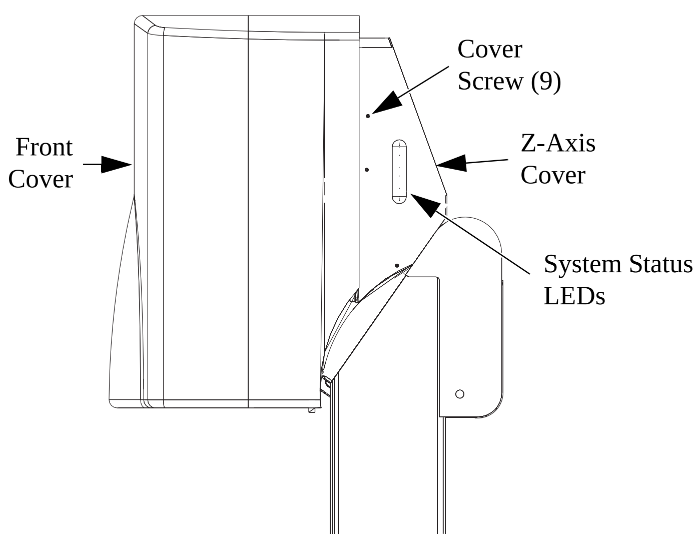


Figure 9-1 Removing the Front Cover and Z-Axis Cover

9.3.2 Removing the Rear Bridge Cover

1. Shut down the system and disconnect the power cord from the power source.

2. If you want to open the rear bridge cover without removing it, loosen the two rear bridge cover screws with a Phillips-head screwdriver and swing the cover will swing down, toward you.

3. If you want to remove the rear bridge cover, **loosen** (do not remove) the eight lower bridge cover screws with a 7/64-inch Allen wrench. Then loosen the rear bridge cover screws with a Phillips-head screwdriver and remove the cover.

4. When ready, reverse the previous steps to close or re-install the rear bridge cover.

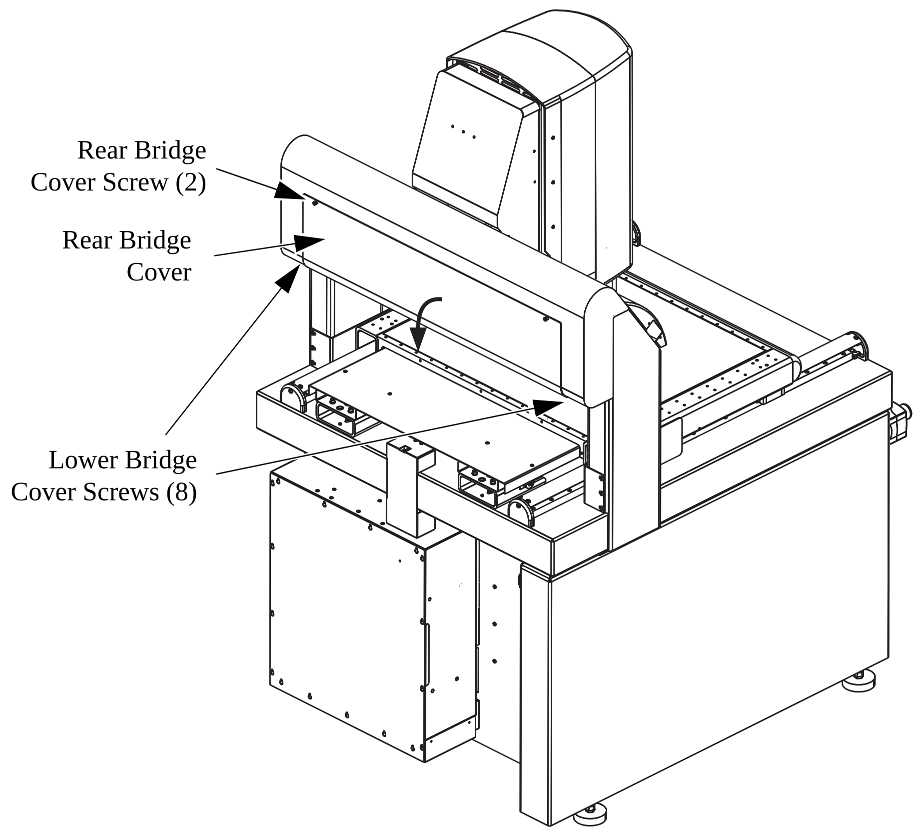


Figure 9-2 Removing the Rear Bridge Cover

9.3.3 Removing the Lower Bridge Cover

1. Shut down the system and disconnect the power cord from the power source.
2. While supporting the lower bridge cover, use a 7/64-inch Allen wrench to remove the eight screws (set of four on each side of the bridge) that secure the lower bridge cover to the machine.
3. Lower the cover straight down to remove it.
4. When ready, reverse the previous steps to re-install the lower bridge cover.

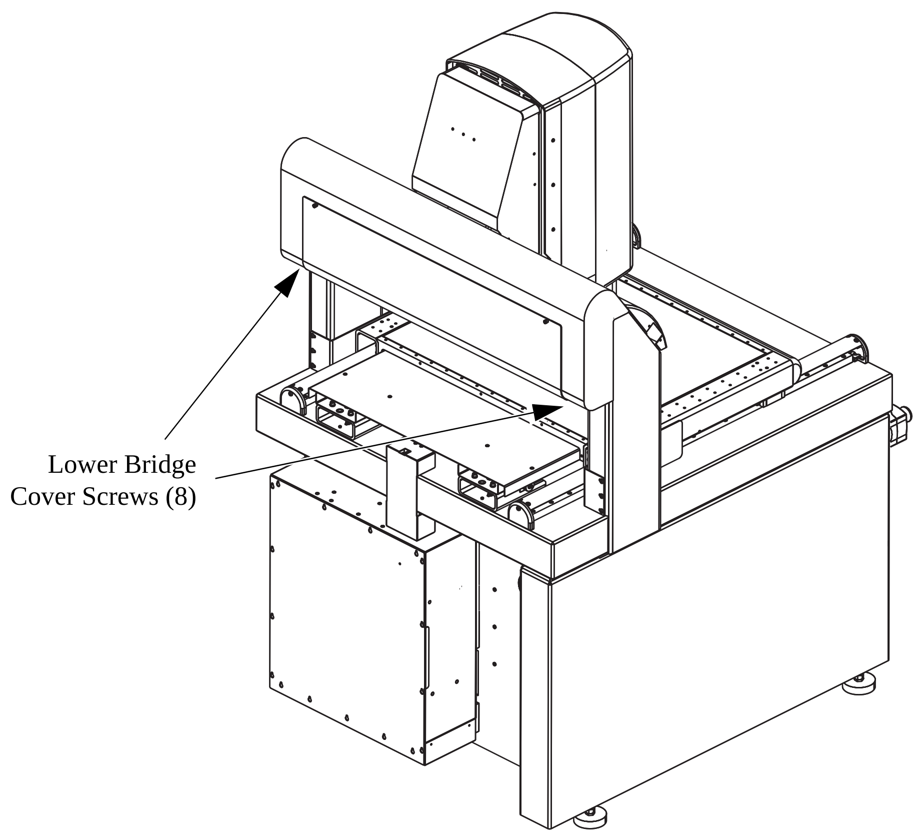


Figure 9-3 Removing the Lower Bridge Cover

9.3.4 Removing the Electronics Enclosure Panel

1. Shut down the system and disconnect the power cord from the power source.

2. Use a Phillips-head screwdriver to loosen (do not remove) the screws around the perimeter of the electronics enclosure panel.

3. Lift the panel straight up until it clears all of the slots. Then pull the panel away from the machine, as indicated by arrow in Figure 9-4.

4. When ready, reverse the previous steps to re-install the electronics enclosure panel.

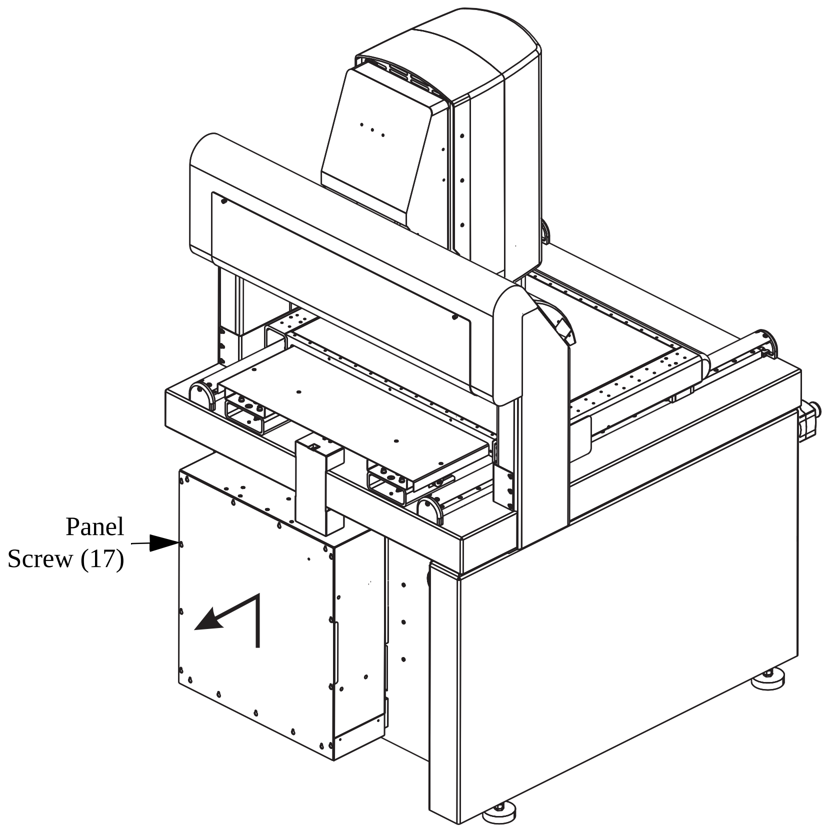


Figure 9-4 Removing the Electronics Enclosure Panel

9.4 Replacing the Magnification Lens

1. Use the joystick to lower the optical assembly so the magnification lens is easily accessible.

2. If the system is equipped with the Programmable Ring Light (PRL), move the PRL to the **0** setting (from within the metrology software) to provide access to the magnification lens.

3. Unscrew the magnification lens (CCW) from the lens tube and carefully set the lens aside.

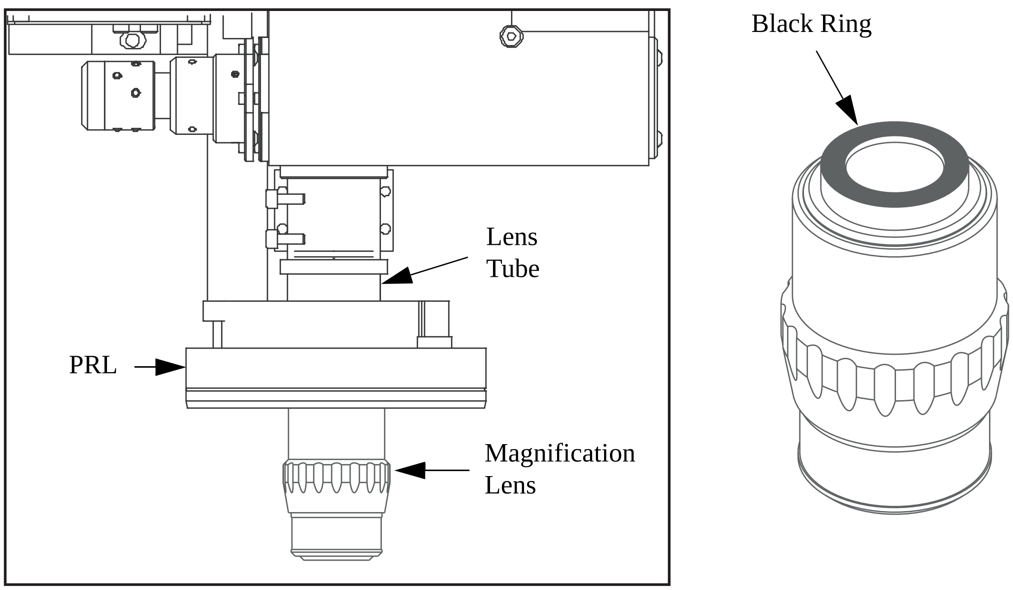


Figure 9-5 Removing the Magnification Lens

4. Install the replacement magnification lens by screwing it (CW) into the threaded opening in the bottom of the lens tube.

5. Select **Setup / Lens Calibration** from the VMS main menu and apply the lens calibration values. If the lens has never been calibrated on the system, perform the ***Lens Calibration*** on page 141.

9.5 Replacing the High & Low Mag Cameras

Tools Required	Part No.
Small Phillips-head screwdriver	N/A
Set of Metric Allen wrenches	N/A

1. Shut down the system and disconnect the power cord from the power source.
2. Remove the front cover by lifting it straight up off its guides.
3. Disconnect the coaxial cable from the top of the camera to be replaced by pulling up on the connector (see Figure 9-6).

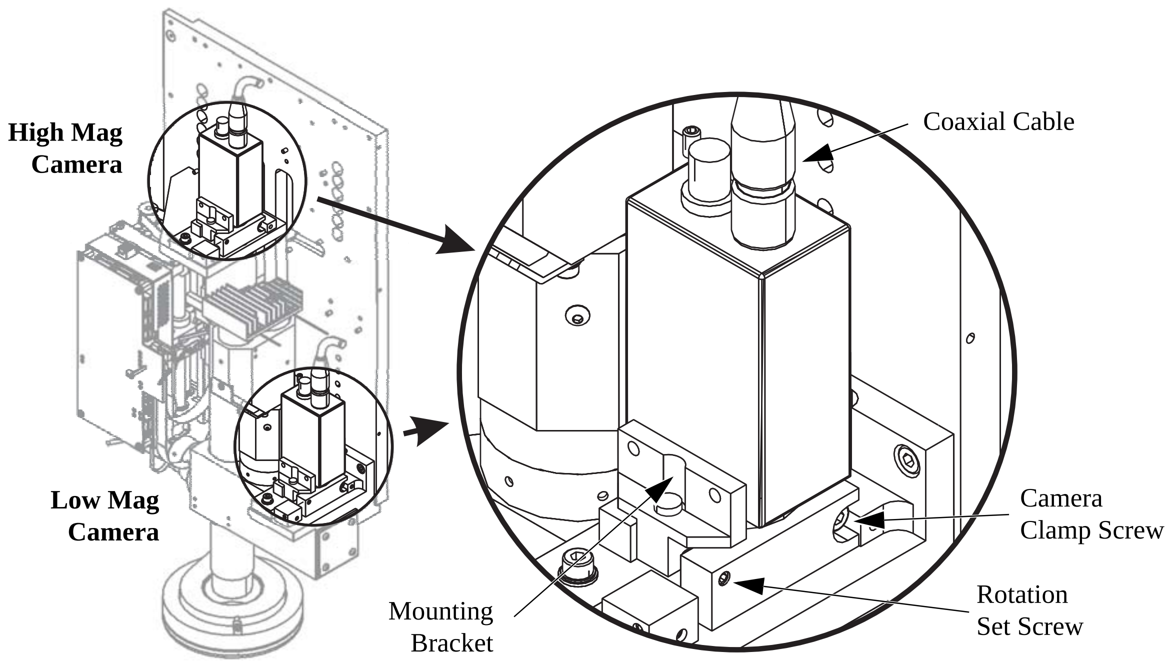


Figure 9-6 Replacing the Camera(s)

4. Loosen the camera clamp set screw.

Note: The high mag camera clamp is accessed from the left, with a *left-hand thread set screw*; i.e., turn CW to loosen, CCW to tighten.

5. There is a rotation set screw on each side of the mounting plate. Loosen either one, but not both, to ensure camera alignment is maintained.

6. Lift the camera (with threaded adapter tube and mounting bracket) out of the camera assembly.

7. Remove the camera mounting screws and washers from the camera mounting bracket. Retain all mounting hardware.

8. Slide the camera and threaded adapter tube out of the mounting bracket.

Caution: Carefully remove and install threaded adapter tubes on the cameras *in a dust-free environment*.

9. Unscrew the camera from the threaded adapter tube.

10. Screw the threaded adapter tube (removed in Step 9) into the replacement camera. Note that these tubes are *not* interchangeable.

11. Put the replacement camera and threaded adapter tube into the camera mounting bracket, and re-install all previously removed mounting hardware.

12. Set the camera (with threaded adapter tube and mounting bracket) in place. Make sure the proper camera is installed in the proper path.

13. Tighten the rotation set screw and the camera clamp set screw.

14. Connect the coaxial cable to the top of the camera.

15. Power up the system and perform the optical adjustment procedures; see ***Dual Magnification Optical System Adjustments*** on page 120.

16. Re-install the front cover.

Note: The Benchmark 450 system comes standard with 1/2" format Low Mag and High Mag cameras. A 2/3" format Low Mag camera is available as an option.

9.6 Replacing the Programmable Ring Light (PRL) (If Equipped)

Tools Required	Part No.
Set of Metric Allen wrenches	N/A

Note: This procedure assumes that the system is already powered up.

1. Use the joystick to raise the optical assembly to the upper limit of travel.

2. Shut down the system and disconnect the power cord from the power source.

3. Remove the front cover by lifting it straight up off its guides.

The PRL assembly is mounted on the left side of the optics plate (see Figure 9-7).

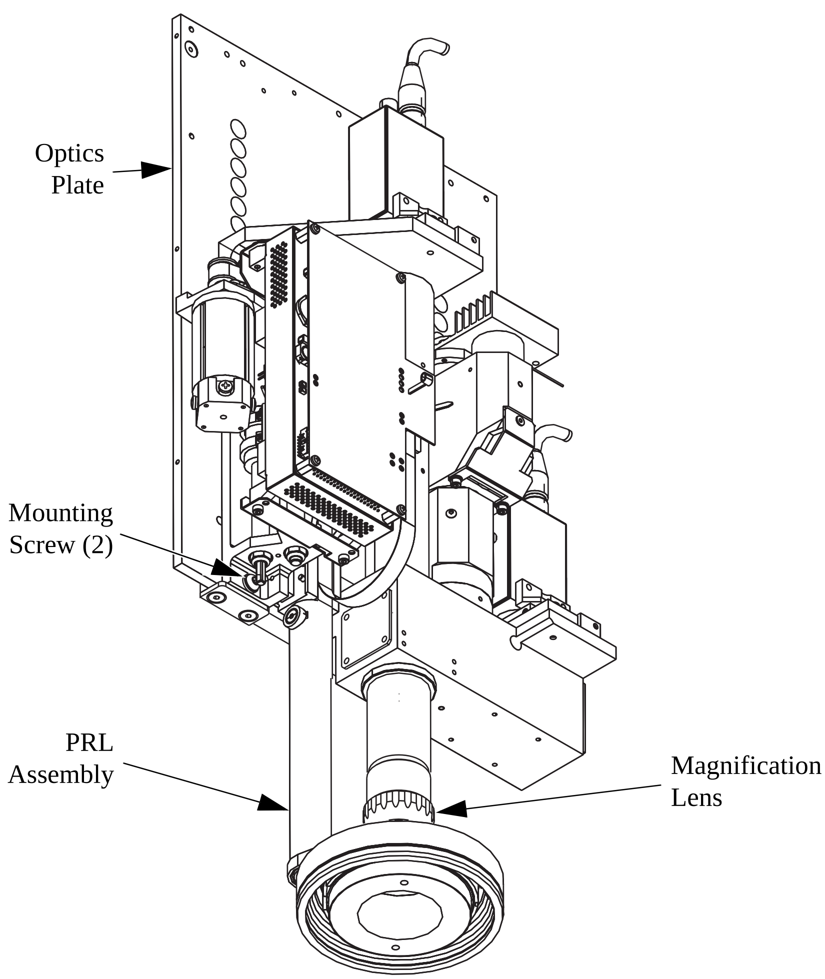


Figure 9-7 Location of PRL Mounting Screws

4. Disconnect all of the cables from the PRL assembly. If necessary, label the connectors to aid in re-installation.

5. Remove the mounting screws that secure the PRL assembly to the optical plate. Retain all mounting hardware.

6. Remove the PRL assembly by lowering it until it clears the magnification lens.

7. Replace the old PRL assembly with the new PRL assembly.

8. Re-install the mounting screws (and washers) that secure the PRL assembly to the optics plate. Then reconnect all previously disconnected cables.

9. Perform the PRL adjustment procedures; see ***LED Programmable Ring Light (PRL) Adjustments (If Equipped)*** on page 146.

10. Re-install the front cover.

9.7 Replacing the AccuCentric Assembly (If Equipped)

Tools Required	Part No.
Set of Metric Allen wrenches	N/A
Wire cutters	N/A
Cable ties	N/A

1. Shut down the system and disconnect the power cord from the power source.
2. Remove the front cover by lifting it straight up. The AccuCentric assembly is located on the left side of the optics (see Figure 9-8).

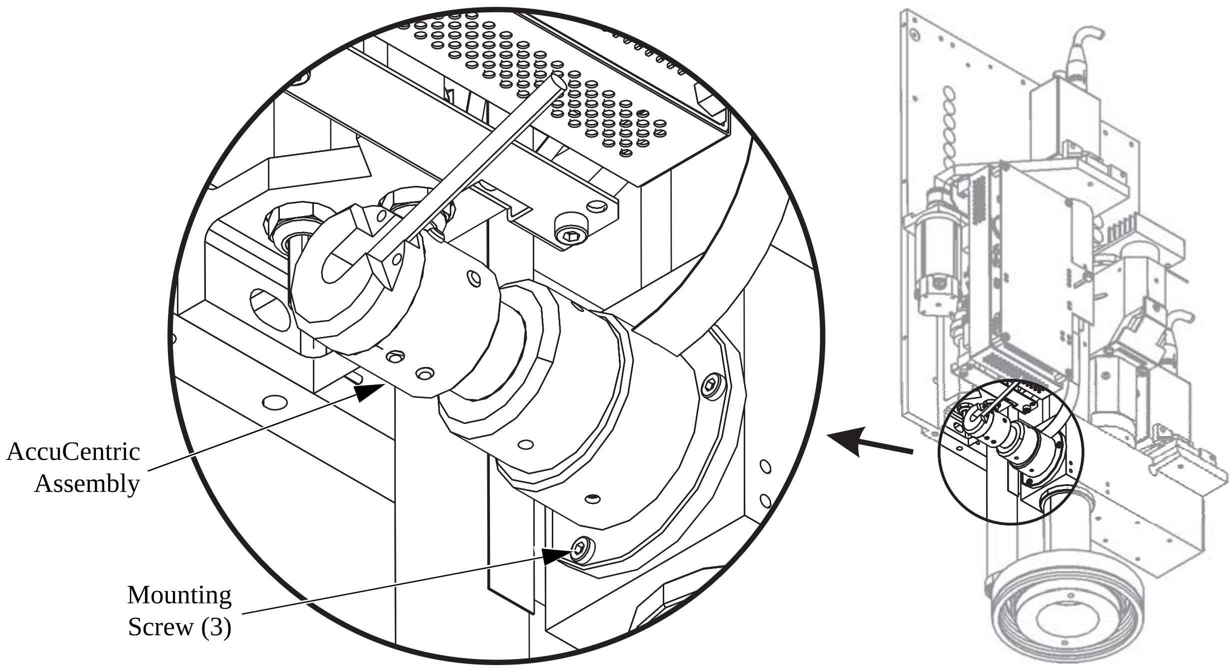


Figure 9-8 Location of the AccuCentric Assembly

3. Follow the AccuCentric cable to the Dual Mag Optics PCBA and disconnect the cable from connector **J615**, cutting the cable ties to free the cable.

4. Remove the mounting screws and washers that secure the AccuCentric assembly to the optical block. Retain all mounting hardware.

5. Replace the old AccuCentric assembly with the new assembly.

6. Re-install the three screws that secure the AccuCentric assembly to the optical block.

7. Connect the AccuCentric cable to connector **J615** on the Dual Mag Optics PCBA and use cable ties to secure the cable.

8. Return the system to normal operation and align the AccuCentric assembly; see ***AccuCentric Assembly Alignment (If Equipped)*** on page 143.

9. Re-install the front cover.

9.8 Replacing the Scale Reader Heads

This section outlines how to replace the following:

- X-axis scale reader head; see ***Replacing the X-Axis Scale Reader Head*** on page 174
- Y-axis scale reader head; see ***Replacing the Y-Axis Scale Reader Head*** on page 178
- Z-axis glass scale and reader head; see ***Replacing the Z-Axis Glass Scale and Reader Head*** on page 181

Caution: Avoid scratching the X- and Y-axis tape scales when replacing the X- and Y-axis scale reader heads.

Note: Retain all mounting hardware during the disassembly process.

9.8.1 Replacing the X-Axis Scale Reader Head

Tools Required	Part No.
Set of Metric Allen wrenches	N/A
Wire cutters	N/A
Cable ties	N/A

1. Shut down the system and disconnect the power cord from the power source.
2. Remove the front cover, Z-axis cover, and the lower bridge cover — see ***Removing the Benchmark 450 Covers*** on page 162.
3. Open the rear bridge cover and disconnect the X-axis scale reader head cable from the extension cable (see Figure 9-9). Both cables are clearly labeled.
4. Use a 2.5 mm Allen wrench to remove the cable restraint bracket.

Note: You can access two of the cable restraint bracket screws from inside the bridge, and the other two from outside the bridge.

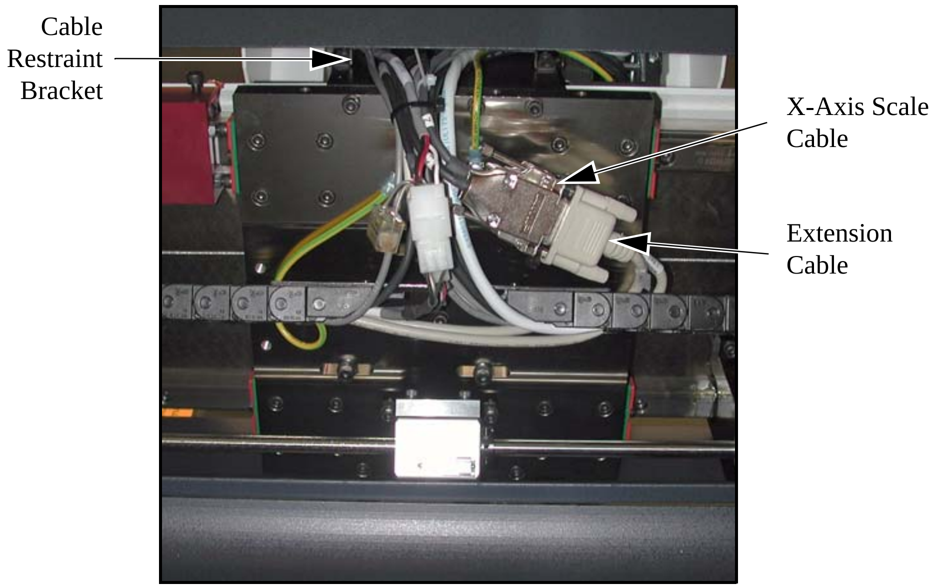


Figure 9-9 Disconnecting the X-Axis Scale Reader Head Cable from the Extension Cable

5. Use a 2.5 mm Allen wrench to remove the cable clamps on the left side of the Z-axis assembly (see Figure 9-10).

6. Free the reader head cable by cutting all the cable-ties.

Caution: Avoid scratching the tape scale when removing the X-axis scale reader head.

7. Use a 3 mm Allen wrench to remove the two screws that secure the reader head mounting bracket and attached reader head to the bridge assembly.

8. Remove the reader head and attached cable from the bridge area.

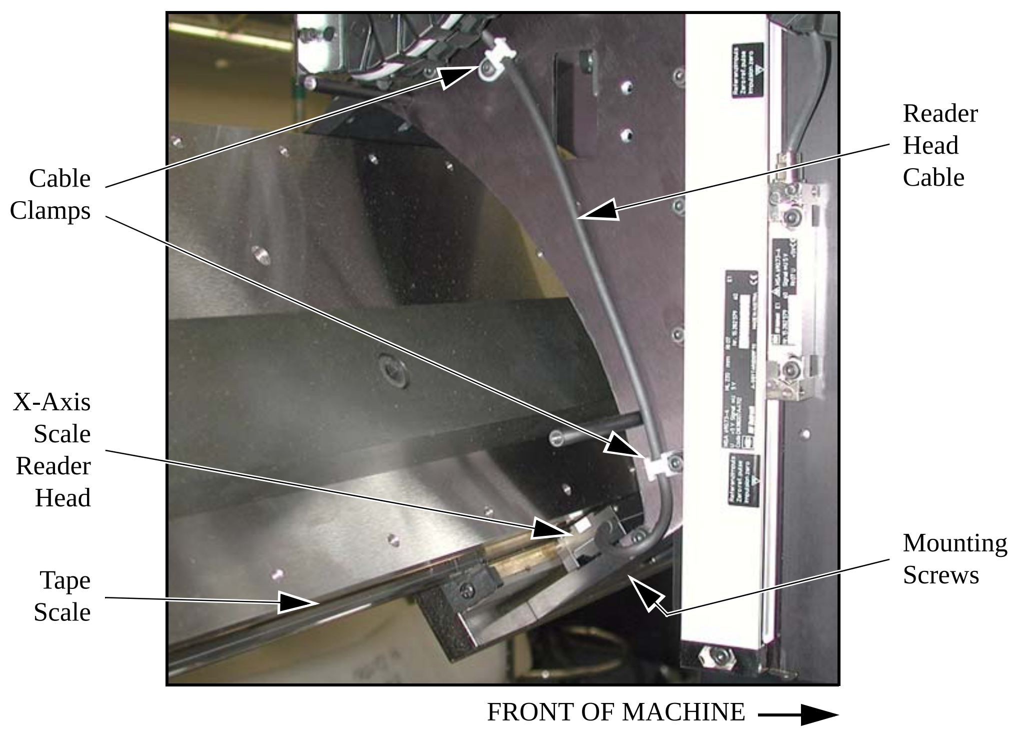


Figure 9-10 Removing the X-Axis Reader Head

9. Using a 2 mm Allen wrench, remove the mounting bracket from the old scale reader head and install it onto the replacement scale reader head.

10. Remove and discard the defective X-axis reader head.

Caution: Avoid scratching the tape scale when installing the replacement reader head.

11. Loosely install the replacement X-axis reader head, using the provided orange spacer tool to align the reader head to the tape scale.

12. Route the reader head cable to the bridge and connect it to the extension cable.

13. Secure the reader head cable in place by replacing all previously removed cable clamps and cable-ties.

14. Re-install the cable restraint bracket (removed in Step 4).

Note: Make sure all of the cables under the cable restraint bracket lie flat and do not overlap each other. This ensures that the bracket will not interfere with the top bridge cover during normal operation.

Caution: Avoid scratching the tape scale when using the orange and blue spacers.

15. Remove the orange spacer and insert the blue 0.8 mm spacer between the reader head and tape scale. Push the reader head toward the tape scale slightly and tighten the reader head mounting screws. Remove the spacer when finished.

Note: You may need to shim behind the reader head to obtain the correct spacing.

Note: Refer to the *Installation Guide* provided with the new reader head for more information about adjusting the reader head.

16. Re-install the covers removed in Step 2.

17. Re-connect the power cord, power up the system, and verify proper system operation. The lamp on the reader head should remain green over the entire length of X travel.

- If the lamp remains green over the entire travel, no adjustment is necessary.
- If the lamp illuminates yellow or red (even for a short period of time) power down the system and re-adjust the spacing between the reader head and tape scale.

Note: The lamp may illuminate yellow or red if the reader head is too close to the scale, too far away from the scale, or not parallel to the scale.

18. Re-calibrate the X and Y axes.

9.8.2 Replacing the Y-Axis Scale Reader Head

Tools Required	Part No.
Set of Metric Allen wrenches	N/A
Small, flat-head screwdriver	N/A
Wire cutters	N/A
Cable ties	N/A

1. Shut down the system and disconnect the power cord from the power source.

Warning: Always power down the machine and disconnect the power cord before removing the electronics enclosure panel.

2. Remove the electronics enclosure panel — see ***Removing the Electronics Enclosure Panel*** on page 165.

3. Disconnect the Y-axis reader head cable from connector **J303** on the DSP Multi Axis PCBA.

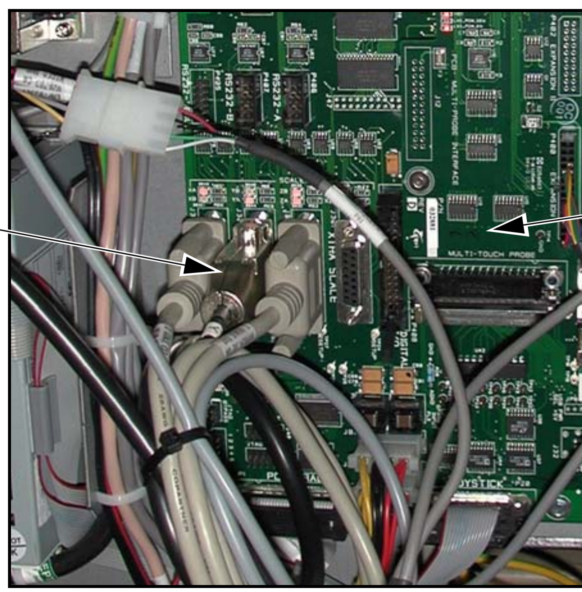


Figure 9-11 Disconnecting the Y-Axis Scale Cable from the DSP Multi Axis PCBA

4. Remove the stage glass.

5. Remove the underlight tray cover.

6. Manually position the worktable so the Y-axis reader head can be accessed through the opening in the substage plate.

7. Use a 3 mm Allen wrench to remove the screws (and washers) that secure the reader head adjustment bracket (and attached scale reader head) to the granite (see Figure 9-12). Retain all mounting hardware.

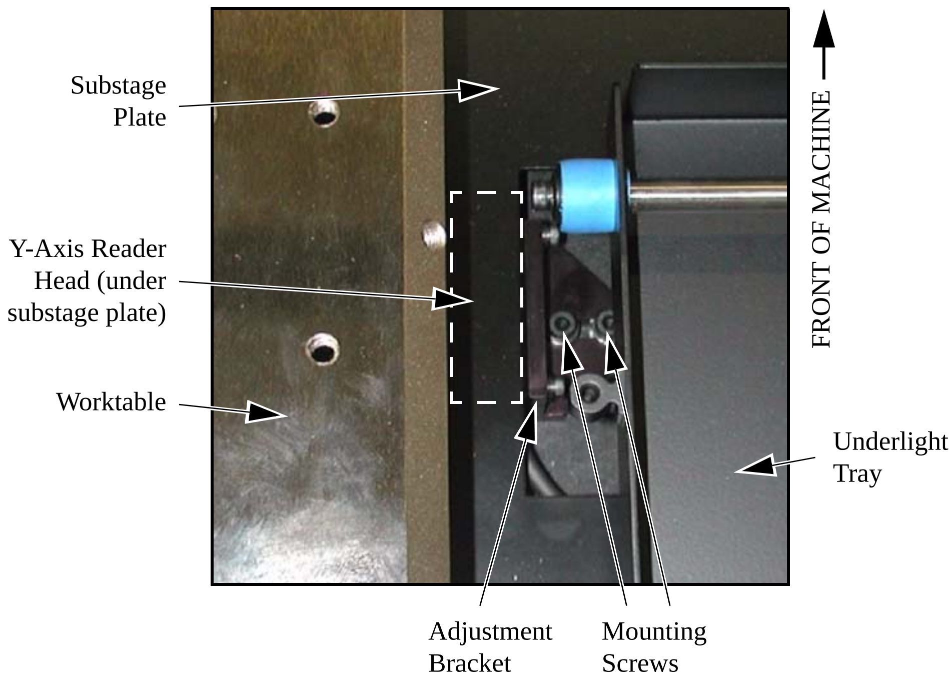


Figure 9-12 Removing the Y-Axis Reader Head

8. Manually push the worktable to the rear limit of travel.

Caution: Avoid scratching the tape scale when removing the Y-axis scale reader head.

9. Remove the reader head adjustment bracket (and attached scale reader head) by pulling it out from under the front of the worktable. The reader head cable should be free to follow.

10. Use a 2 mm Allen wrench to remove the adjustment bracket from the old Y-axis reader head and install it onto the replacement reader head.

11. Discard the defective reader head.

12. Feed the new reader head cable through the through the access hole in the granite and into the electronics enclosure.

13. Connect the Y-axis reader head cable to connector **J303** on the DSP Multi Axis PCBA.

14. Replace all previously removed cable-ties.

15. Re-install the electronics enclosure panel.

16. Use the mounting hardware removed in Step 7 to attach loosely the reader head adjustment bracket (and attached reader head) to the granite.

Caution: Avoid scratching the tape scale when using the blue spacer.

17. Use the blue 0.8 mm spacer to position the reader head the correct distance away from the tape scale. When finished, tighten the adjustment screws and remove the blue spacer.

18. Re-connect the power cord, power up the system, and verify proper system operation. The lamp on the reader head should remain green over the entire length of Y travel.
    - If the lamp remains green over the entire travel, no adjustment is necessary.
    - If the lamp illuminates yellow or red (even for a short period of time) power down the system and re-adjust the spacing between the reader head and tape scale.

Note: The lamp may illuminate yellow or red if the reader head is too close to the scale, too far away from the scale, or not parallel to the scale.

Caution: Avoid removing the rubber washers glued to the underlight tray when re-installing the underlight tray cover.

19. Shut down the system and disconnect the power cord from the power source.

20. Re-install the underlight tray cover and stage glass.

21. Verify that the stage glass is level; re-level if necessary.

22. Re-calibrate the X and Y axes.

9.8.3 Replacing the Z-Axis Glass Scale and Reader Head

Tools Required	Part No.
Set of Metric Allen wrenches	N/A
Small, flat-head screwdriver	N/A
Wire cutters	N/A
Cable ties	N/A
Micrometer	N/A

1. Position the Z-axis transport at the approximate center of Z travel.
2. Shut down the system and disconnect the power cord from the power source.
3. Remove the front cover and Z-axis cover — see ***Removing the Benchmark 450 Covers*** on page 162.
4. Open the rear bridge cover and disconnect the Z-axis reader head cable from the extension cable. Both cables are clearly labeled.
5. Use a 2.5 mm Allen wrench to remove the cable restraint bracket.

Note: You can access two of the cable restraint bracket screws from inside the bridge, and the other two from outside the bridge.

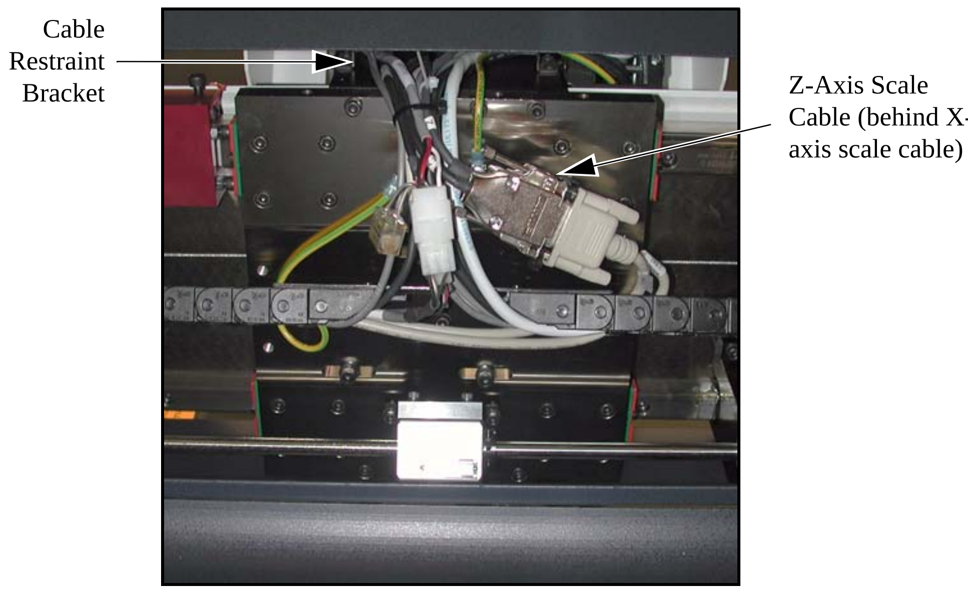


Figure 9-13 Disconnecting the Z-Axis Scale Cable from the Extension Cable

6. Remove the reader head cable from the cable track and free the cable by cutting the cable-ties.

Caution: Use extreme care whenever handling the glass scale and reader head. They are delicate components and will not withstand rough handling. In particular, make sure the reader head is not allowed to move quickly to the extreme ends of the glass scale.

7. Use a 3 mm Allen wrench to remove the glass scale and reader head (see Figure 9-14). Retain all mounting hardware.

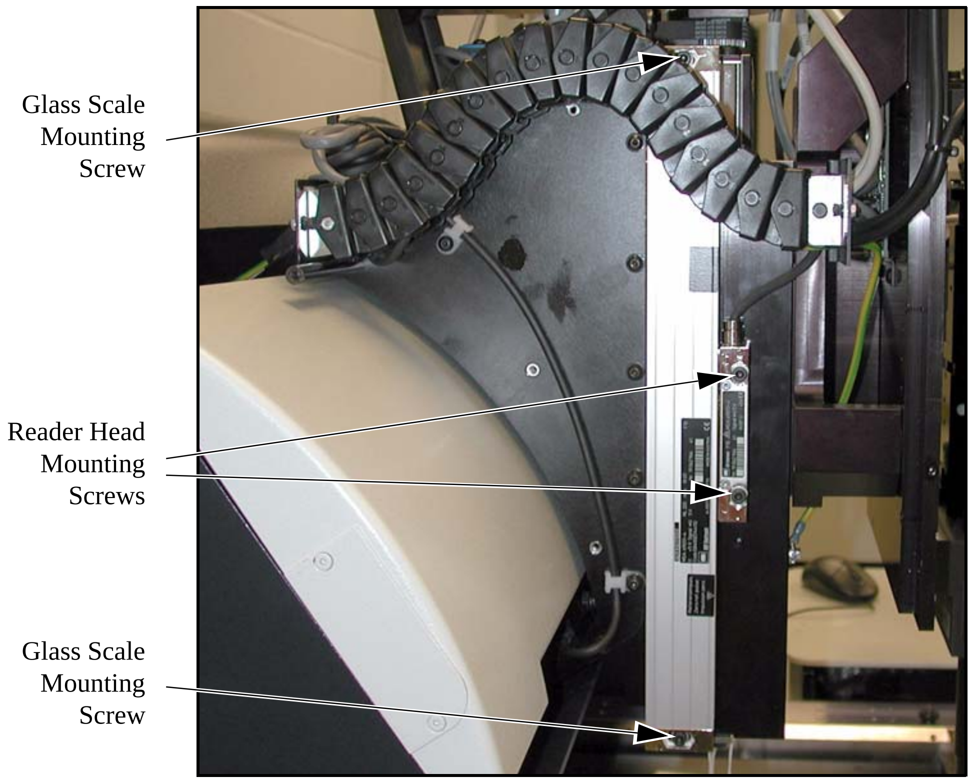


Figure 9-14 Removing the Z-Axis Glass Scale and Reader Head

8. Discard the defective glass scale and scale reader head. (The reader head cable should be free to follow.)

9. Remove the new glass scale and scale reader head from its package.

10. Use a small flat-head screwdriver to remove and discard the shipping screw (see Figure 9-15). Then remove (but do not discard) the reader head spacer.

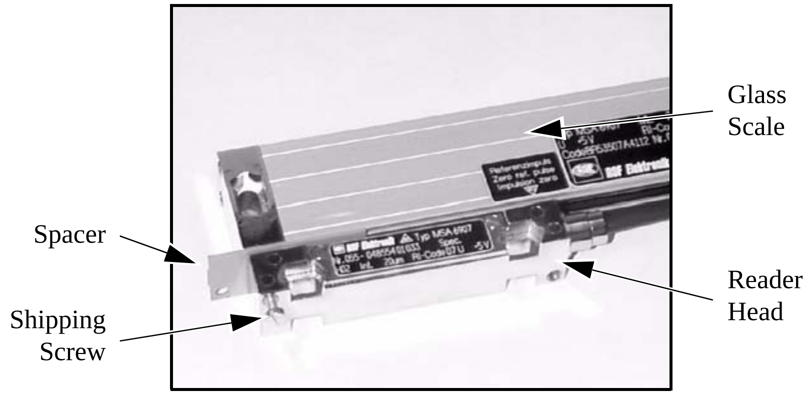


Figure 9-15 Removing the Z-Axis Glass Scale Shipping Screw

11. Use the screws and washers removed in Step 7 to mount loosely the replacement glass scale and reader head to the left side of the Z-axis assembly. Use the upper set of mounting holes on the side of the Z-axis slide. Be sure to observe the CAUTION note listed before Step 7 whenever handling the glass scale and read head.

12. Use a micrometer to position the Z-axis glass scale so it is square (±0.0254 mm; ±0.001") to the machined (front) surface of the Z-axis slide. Make sure that you measure to the outboard edge of the scale, at both ends of the scale. After it is correctly positioned, tighten the scale mounting screws to secure the glass scale to the Z-axis slide.

13. Use the reader head spacer (removed in Step 10) to position the reader head so it is a spacer-thickness away from the glass scale. After the read head is positioned correctly, tighten the reader head mounting screws to secure the reader head to the Z-axis slide.

14. Route the reader head cable to the bridge and connect it to the scale extension cable. Secure the cable to the machine by inserting it into the cable track and re-installing all previously removed cable-ties.

15. Re-install the cable restraint bracket (removed in Step 5) and close the rear bridge cover. Then re-install the front cover and Z-axis cover.

16. Re-connect the power cord, power up the system, and verify proper system operation.

17. Re-calibrate the Z-axis.

9.9 Replacing the Motors

This section outlines how to replace the following:

- X-axis motor; see ***Replacing the X-Axis Motor*** on page 185
- Y-axis motor; see ***Replacing the Y-Axis Motor*** on page 187
- Z-axis motor; see ***Replacing the Z-Axis Motor*** on page 190

Note: Retain all mounting hardware during the disassembly process.

9.9.1 Replacing the X-Axis Motor

Tools Required	Part No.
Set of Metric Allen wrenches	N/A
Set of English Allen wrenches	N/A
Replacement X-axis motor	030270

1. Shut down the system and disconnect the power cord from the power source.
2. Remove the lower bridge cover and the rear bridge cover — see ***Removing the Benchmark 450 Covers*** on page 162.
3. Unplug the two X-axis motor cables. Both cables are clearly labeled.
4. Use a 7/64-inch Allen wrench to **loosen** (do not remove) the motor mounting screws, which releases the tension on the X-axis drive belt.

Note: Use the access hole on the right side of the machine to access the motor mounting screw closest to the back of the machine.

5. Remove the X-axis drive belt and set it aside.
6. While supporting the motor, remove the mounting screws that secure the motor to the mounting bracket (see Figure 9-16). Retain all mounting hardware.

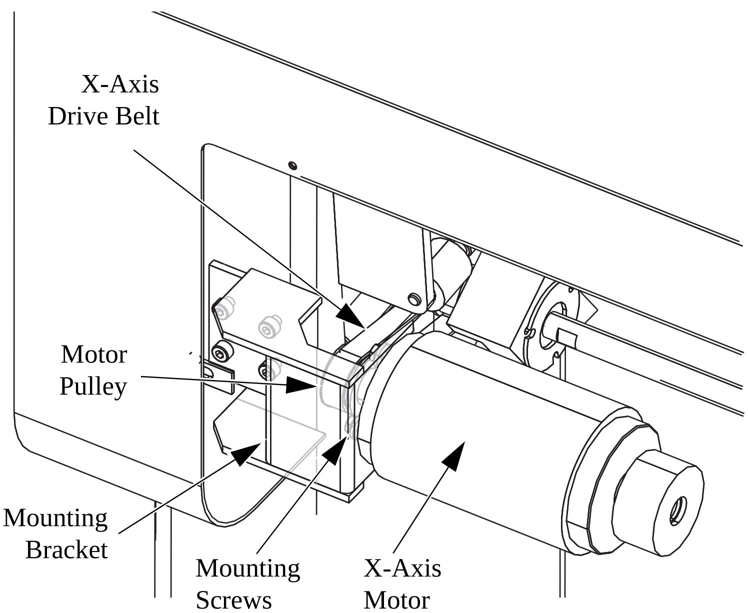


Figure 9-16 Replacing the X-Axis Motor

7. Remove the old X-axis motor from the bridge assembly.

8. Use a 2 mm Allen wrench to loosen the two motor pulley set screws. Then remove the pulley by sliding it off the motor shaft.

9. Install the motor pulley onto the replacement motor.

10. Use the mounting hardware removed in Step 6 to install the replacement motor loosely.

11. Slip the drive belt onto the motor pulley and drive pulley.

12. Position the motor so the drive belt is snug. Make sure the belt is centered within the motor pulley and drive pulley, and then tighten the motor mounting screws.

13. Re-install the lower bridge cover and the rear bridge cover.

14. Re-connect the power cord, power up the system, and verify proper system operation.

9.9.2 Replacing the Y-Axis Motor

Tools Required	Part No.
Set of Metric Allen wrenches	N/A
Set of English Allen wrenches	N/A

1. Shut down the system and disconnect the power cord from the power source.
2. Use a 3/32-inch Allen wrench to loosen the two screws on top of the Y-axis motor cover (see Figure 9-17). Then use a 7/64-inch Allen wrench to remove the two side screws.
3. Remove the motor cover and set is aside.

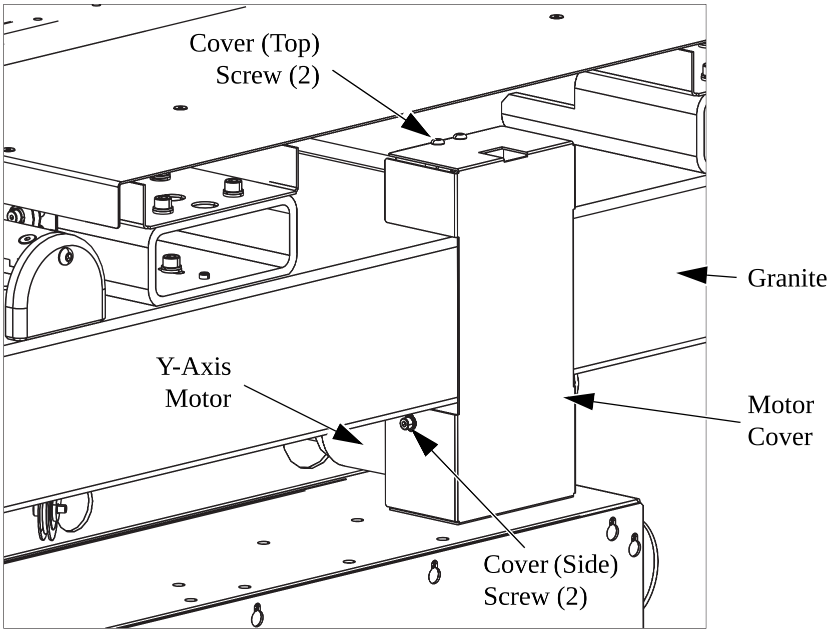


Figure 9-17 Removing the Y-Axis Motor Cover

4. Use a 7/64-inch Allen wrench to **loosen** (do not remove) the motor mounting screws, which releases the tension on the Y-axis drive belt.

5. Remove the Y-axis drive belt and set it aside.

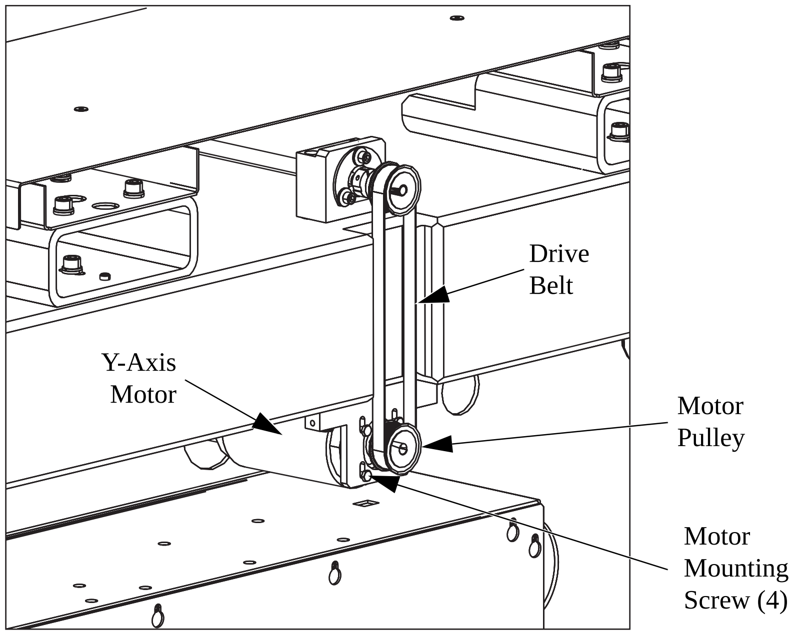


Figure 9-18 Removing the Y-Axis Motor

6. Use a 1.5 mm Allen wrench to **loosen** (do not remove) the two motor pulley set screws. Remove the pulley and set it aside.

7. While supporting the Y-axis motor, remove the four motor mounting screws. Retain all mounting hardware.

8. Carefully pull the motor and encoder connectors out through the hole in the base of the machine.

9. Unplug the motor and encoder cables.

10. Replace the old Y-axis motor with the replacement motor.

11. Connect the motor and encoder cables.
12. Feed the motor and encoder cables into the base of the machine and loosely mount the motor using the mounting hardware removed in Step 7.
13. Slide the motor pulley onto the motor shaft and tighten the pulley set screws.
14. Slip the drive belt onto the motor pulley and drive pulley.
15. Tighten the motor mounting screws.
16. Re-install the Y-axis motor cover.

9.9.3 Replacing the Z-Axis Motor

Tools Required	Part No.
Set of Metric Allen wrenches	N/A
Set of English Allen wrenches	N/A
Small, flat-head screwdriver	N/A
Cable-ties	N/A

1. Shut down the system and disconnect the power cord from the power source.
2. Remove the front cover and Z-axis cover — see ***Removing the Benchmark 450 Covers*** on page 162.
3. Use a Phillips-head screwdriver to open the rear bridge cover.
4. Locate the Z-axis motor cables and disconnect them. The cables are clearly labeled.
5. Use a 2.5 mm Allen wrench to remove the cable restraint bracket.

Note: You can access two of the cable restraint bracket screws from inside the bridge, and the other two from outside the bridge.

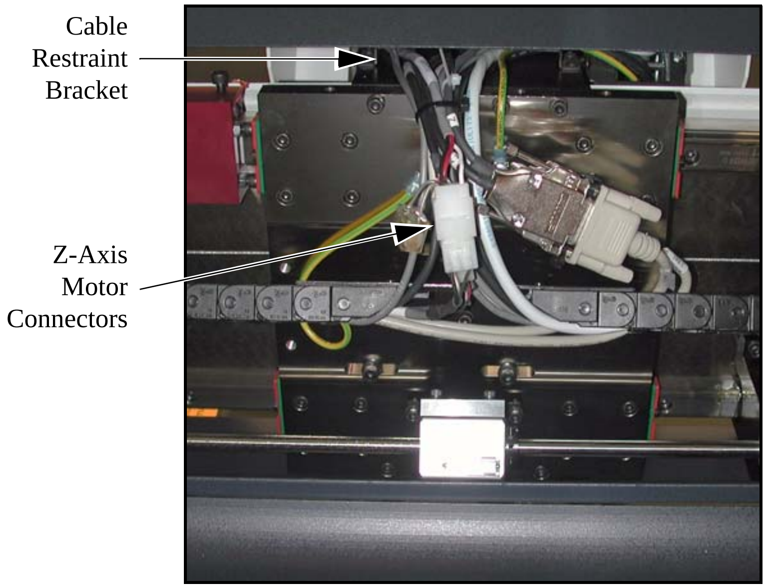


Figure 9-19 Disconnecting the Z-Axis Motor Connectors

6. Free the Z-axis motor cables by cutting the necessary cable-ties.

7. Use a 3 mm Allen wrench to remove the five screws that secure the Z-axis cover bracket to the machine (see Figure 9-20). Remove the bracket and set it aside. Retain all mounting hardware.

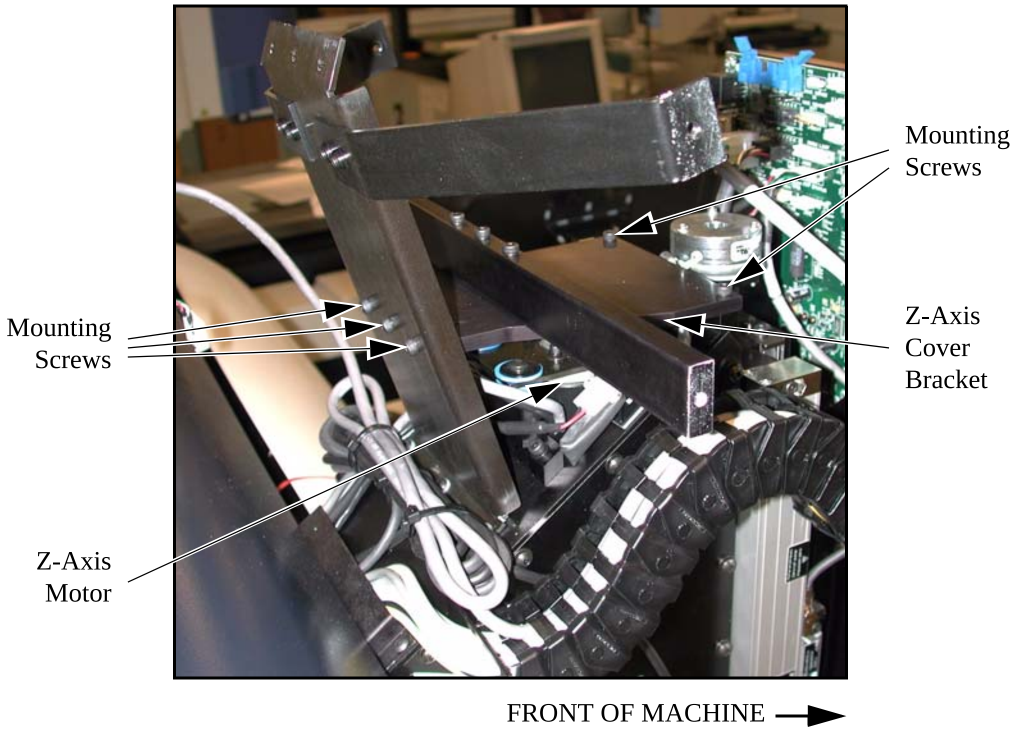


Figure 9-20 Removing the Z-Axis Cover Bracket

8. Use a 7/64-inch Allen wrench to **loosen** (do not remove) the motor mounting screws, which releases the tension on the drive belt.

9. Remove the drive belt and set it aside.

10. Use a 2 mm Allen wrench to **loosen** the two motor pulley set screws. Remove the pulley and set it aside.

Note: Before removing the motor mounting bracket, note the eight blue, rubber washers. Be sure to re-install them during re-assembly.

---

11. While supporting the Z-axis motor mounting bracket, remove the four screws that secure it (and the attached motor) to the machine. Retain all mounting hardware.

12. Lift the motor mounting bracket (and attached motor) straight up to remove it.

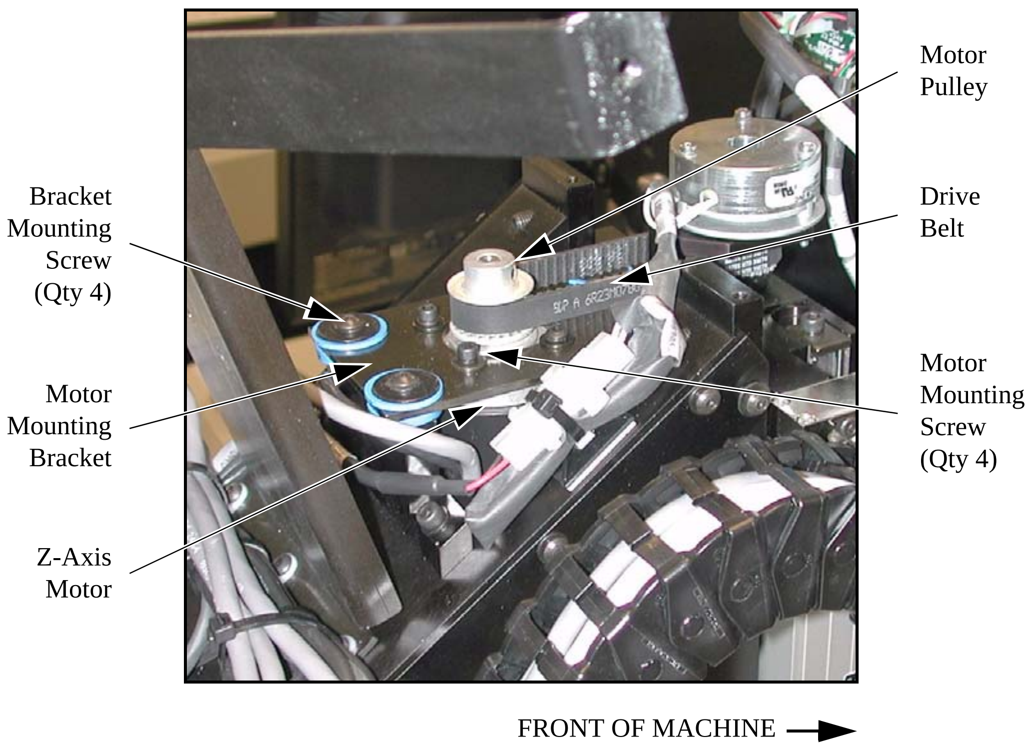


Figure 9-21 Removing the Z-Axis Motor

13. Use a 7/64-inch Allen wrench to remove the four screws that secure the motor to the mounting bracket. Retain all mounting hardware.
14. Replace the old Z-axis motor with the replacement motor.
15. Use the mounting hardware removed in Step 13 to attach the replacement motor loosely to the mounting bracket.
16. Slide the motor pulley onto the motor shaft and tighten the two pulley set screws.
17. Set the motor mounting bracket (and attached motor) onto the motor housing and install the mounting hardware removed in Step 11.
18. Slip the drive belt onto the motor pulley and drive pulley.
19. Position the Z-axis motor to tension the drive belt so it is snug. Make sure the belt is centered within the motor pulley and drive pulley, and then tighten the motor mounting screws.
20. Verify that the drive belt is parallel to the stage; adjust the height of the motor pulley if necessary.
21. Route the motor cables to the bridge and re-connect the cables to the extension cables.
22. Replace all previously removed cable-ties.
23. Use the mounting hardware removed in Step 7 to re-install the Z-axis cover bracket.
24. Close the rear bridge cover and re-install the Z-axis cover and front cover.
25. Re-connect the power cord, power up the system, and verify proper system operation.

9.10 Replacing the Main Power Fuse(s)

The main power fuse(s) is located in the fuse holder that is part of the On/Off switch and power cord receptacle assembly (see Figure 9-22). There is a fuse label near the fuse holder that indicates the type of fuse(s) installed. Before replacing a blown fuse determine the reason why it failed and fix the problem. Contact your local Service Representative for assistance.

To replace the main power fuse(s), follow the steps below.

Warning: Always power down the machine and disconnect the power cord before replacing the main power fuse.

---

1. Shut down the system and disconnect the power cord from the power source.

2. Pry open the fuse compartment door with a small, flat-head screwdriver.

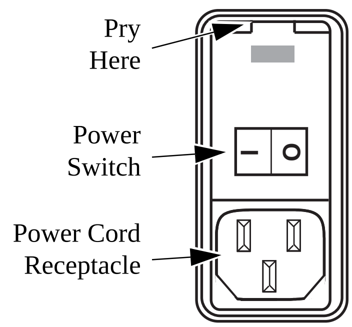


Figure 9-22 Replacing the Main Power Fuse(s)

Caution: Always replace with fuses of the same type and amperage. Replacing with a different type or rating can damage electrical circuits and void your warranty. If your power requirements change, you must change the fuse configuration accordingly.

---

3. Pull out the fuse holder, replace the fuse(s), and then re-install the fuse holder.

- Systems configured for 100/120 volt operation use one 10 Amp, 250 volt, Slo Blo fuse (P/N 19459). (A conversion clip is installed on the side without the fuse.)
- Systems configured for 220/240 volt operation use two 6.3 Amp, 250 volt, Slo Blo fuses.

Note: If the machine has two fuses, be sure check both fuses.

9.11 Replacing the PCBAs

Caution: Protect the Benchmark 450 system from electrostatic damage. Perform these procedures at a static-safe workstation and wear a ground strap. If a ground strap is not available, follow these guidelines:

- Work in an uncarpeted area.
- Discharge static electricity before handling electronic components by touching a known-rounded object.
- Do not touch components on printed circuit boards assemblies (PCBAs), except as directed.

Note: For each new PCBA that is installed, record the jumpers installed, switch positions, PCBA revision, and firmware revision. You might want to attach a sticker to the new PCBAs so you differentiate them from the old PCBAs.

Note: Before disconnecting any cables or removing any PCBAs, note all cable connections and cable routing.

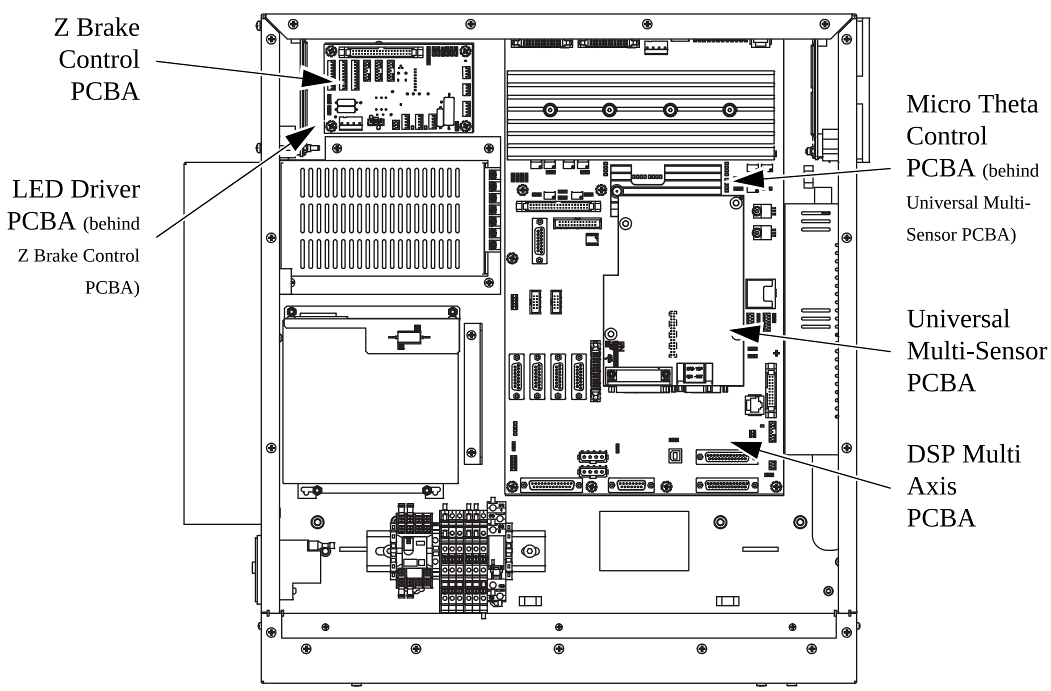


Figure 9-23 Location of Benchmark 450 PCBAs in Electronics Enclosure (Rear Panel Removed)

Note: The Dual Mag Optics PCBA is located behind the optics plate.

9.11.1 Replacing the DSP Multi Axis PCBA

Tools Required	Part No.
Phillips-head screwdriver	N/A
Plastic, anti-static bag	N/A

1. Shut down the system and disconnect the power cord from the power source.

Warning: Always power down the machine and disconnect the power cord before removing the electronics enclosure panel.

2. Remove the electronics enclosure panel — see ***Removing the Electronics Enclosure Panel*** on page 165.

The DSP Multi Axis PCBA is mounted to the back interior wall of the Electronics Enclosure (see Figure 9-24).

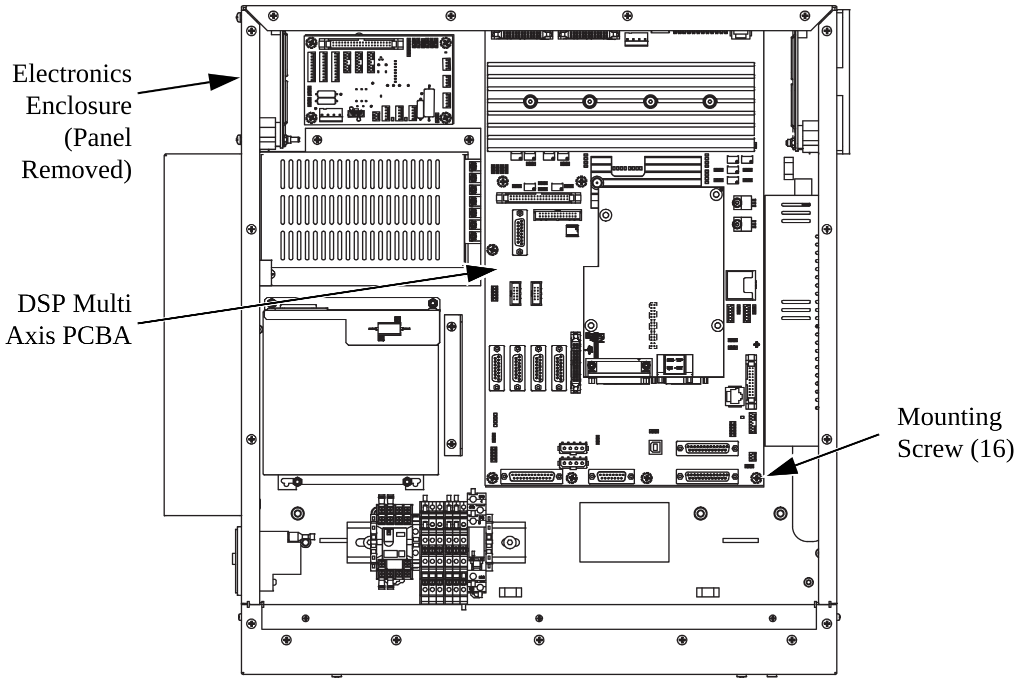


Figure 9-24 Location of the DSP Multi Axis PCBA

3. If there are any daughter boards mounted on the DSP Multi Axis PCBA, remove them before continuing.

    - If the system is equipped with a laser sensor, see ***Replacing the Universal Multisensor PCBA (If Equipped)*** on page 204.
    - If the system is equipped with a rotary indexer, see ***Replacing the Micro Theta Control PCBA (If Equipped)*** on page 206.

4. Disconnect all of the cables from the DSP Multi Axis PCBA. If necessary, label the connectors to aid in re-assembly.

Note: Be sure to disconnect the Chassis Ground (J31) from the DSP Multi Axis PCBA because a new one is not supplied with the replacement board.

---

5. Use a Phillips-head screwdriver to remove the mounting screws (and washers) that secure the DSP Multi Axis PCBA to the electronics enclosure. Retain all mounting hardware.
6. Remove the DSP Multi Axis PCBA from the electronics enclosure and place it in a plastic, anti-static bag.
7. Use the mounting hardware removed in Step 5 to install the replacement DSP Multi Axis PCBA, in the same orientation as the old board.
8. Re-connect all previously disconnected cables.
9. Re-install all previously removed daughter boards.
10. Re-install the electronics enclosure panel.
11. Re-connect the power cord, power up the system, and verify proper system operation.

9.11.2 Replacing the Z Brake Control PCBA

Tools Required	Part No.
Phillips-head screwdriver	N/A
Plastic, anti-static bag	N/A

1. Shut down the system and disconnect the power cord from the power source.

Warning: Always power down the machine and disconnect the power cord before removing the electronics enclosure panel.

2. Remove the electronics enclosure panel — see ***Removing the Electronics Enclosure Panel*** on page 165.

The Z Brake Control PCBA is located in the upper-left corner of the electronics enclosure (see Figure 9-25).

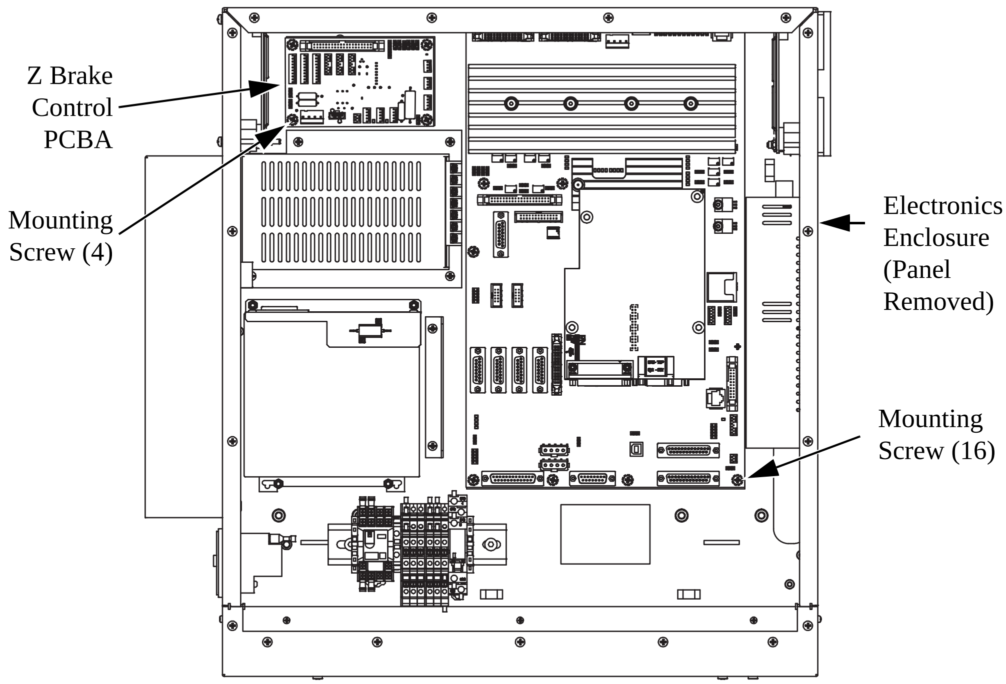


Figure 9-25 Location of the Z Brake Control PCBA

3. Disconnect all of the cables from the Z Brake Control PCBA. If necessary, label the connectors to aid in re-assembly.

4. Use a Phillips-head screwdriver to remove the four mounting screws that secure the Z Brake Control PCBA to the electronics enclosure. Retain all mounting hardware.

5. Remove the old Z Brake Control PCBA from the electronics enclosure and place it in a plastic, anti-static bag.

6. Use the mounting hardware removed in Step 4 to install the replacement Z Brake Control PCBA, in the same orientation as the old board.

7. Re-connect all previously disconnected cables.

8. Re-install the electronics enclosure panel.

9. Re-connect the power cord, power up the system, and verify proper system operation.

9.11.3 Replacing the LED Driver PCBA

Tools Required	Part No.
Phillips-head screwdriver	N/A
Plastic, anti-static bag	N/A

1. Shut down the system and disconnect the power cord from the power source.

Warning: Always power down the machine and disconnect the power cord before removing the electronics enclosure panel.

2. Remove the electronics enclosure panel — see ***Removing the Electronics Enclosure Panel*** on page 165.

The LED Driver PCBA is located in the upper-left corner of the electronics enclosure, behind the Z Brake Control PCBA (see Figure 9-26).

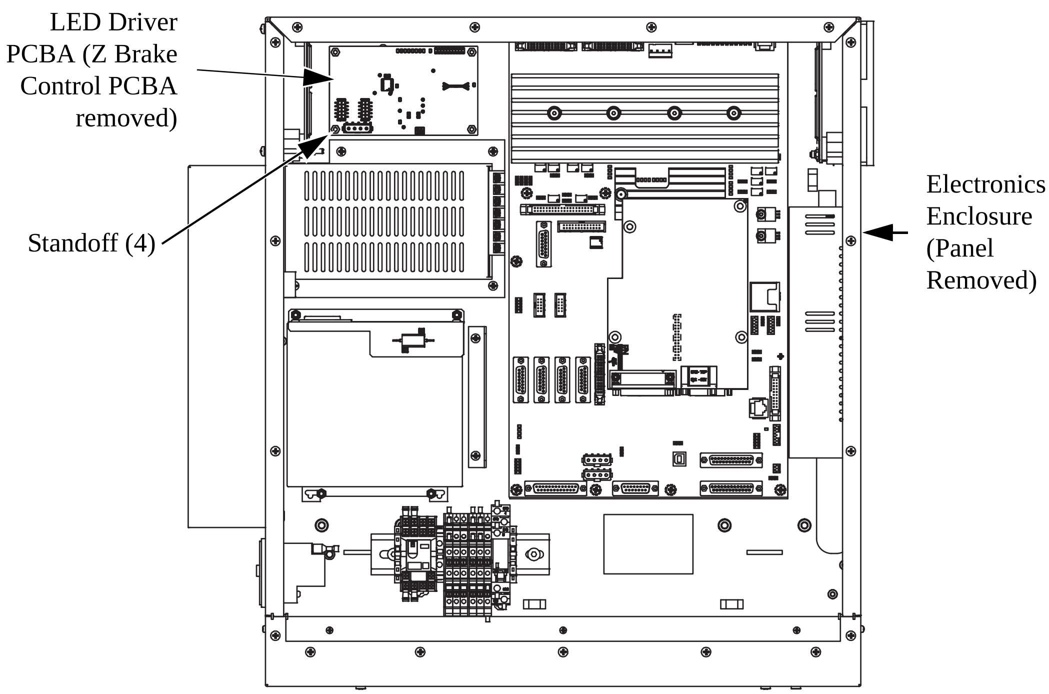


Figure 9-26 Location of the LED Driver PCBA

3. Remove the Z Brake Control PCBA; see ***Replacing the Z Brake Control PCBA*** on page 198.
4. Disconnect all of the cables from the LED Driver PCBA. If necessary, label the connectors to aid in re-assembly.
5. Remove the standoffs that secure the LED Driver PCBA to the electronics enclosure. Retain all mounting hardware.
6. Remove the old LED Driver PCBA from the electronics enclosure and put it in a plastic, anti-static bag.
7. Use the standoffs removed in Step 5 to install the replacement LED Driver PCBA, in the same orientation as the old board.
8. Re-install the Z Brake Control PCBA.
9. Re-connect all previously disconnected cables.
10. Re-install the electronics enclosure panel.
11. Re-connect the power cord, power up the system, and verify proper system operation.

9.11.4 Replacing the Dual Mag Optics PCBA

Tools Required	Part No.
Phillips-head screwdriver	N/A

1. Shut down the system and disconnect the power cord from the power source.

2. Remove the front cover by lifting it straight up off its guides.

The Dual Mag Optics PCBA is located behind the optical assembly (see Figure 9-27).

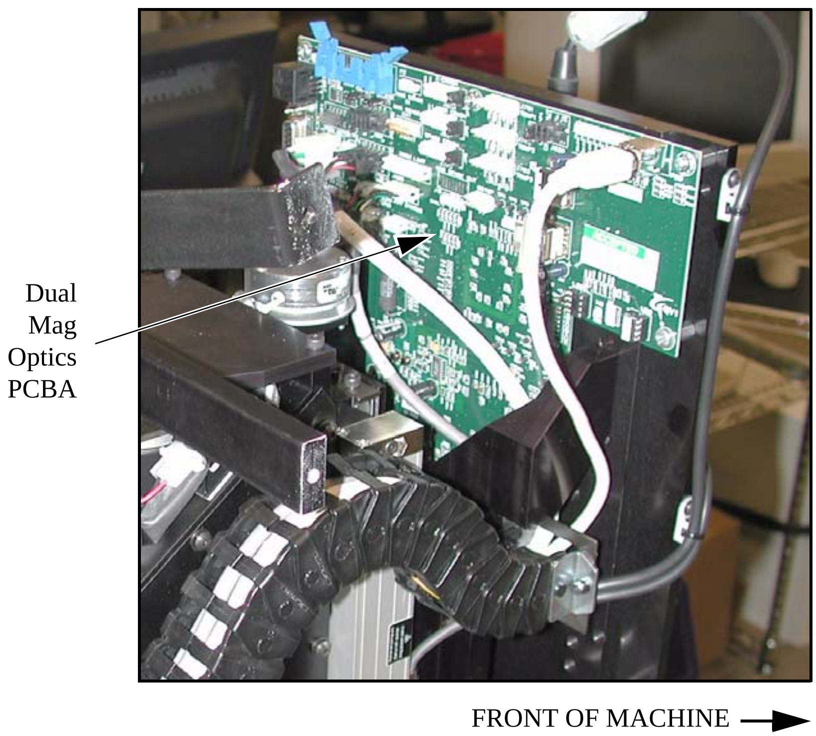


Figure 9-27 Location of the Dual Mag Optics PCBA (Front Cover Removed)

3. Disconnect all cables from the Dual Mag Optics PCBA. If necessary, label the connectors to aid in re-assembly.

4. Use a Phillips-head screwdriver to remove the four mounting screws that secure the Dual Mag Optics PCBA to the machine. Retain all mounting hardware.

5. Remove the old Dual Mag Optics PCBA and put it in a plastic, anti-static bag.

6. Use the mounting hardware removed in Step 4 to install the replacement Dual Mag Optics PCBA, in the same orientation as the old board.

7. Re-connect all previously disconnected cables.

8. Re-install the front cover.

9. Re-connect the power cord, power up the system, and verify proper system operation.

9.11.5 Replacing the Universal Multisensor PCBA (If Equipped)

Tools Required	Part No.
Phillips-head screwdriver	N/A
Set of Metric hex key (Allen) wrenches	N/A
Plastic, anti-static bag	N/A

1. Shut down the system and disconnect the power cord from the power source.

Warning: Always power down the machine and disconnect the power cord before removing the electronics enclosure panel.

2. Remove the electronics enclosure panel — see ***Removing the Electronics Enclosure Panel*** on page 165.

The Universal Multisensor PCBA is mounted to the DSP Multi Axis PCBA (connected to P400) or Micro Theta Control PCBA if the system is equipped with a rotary indexer.

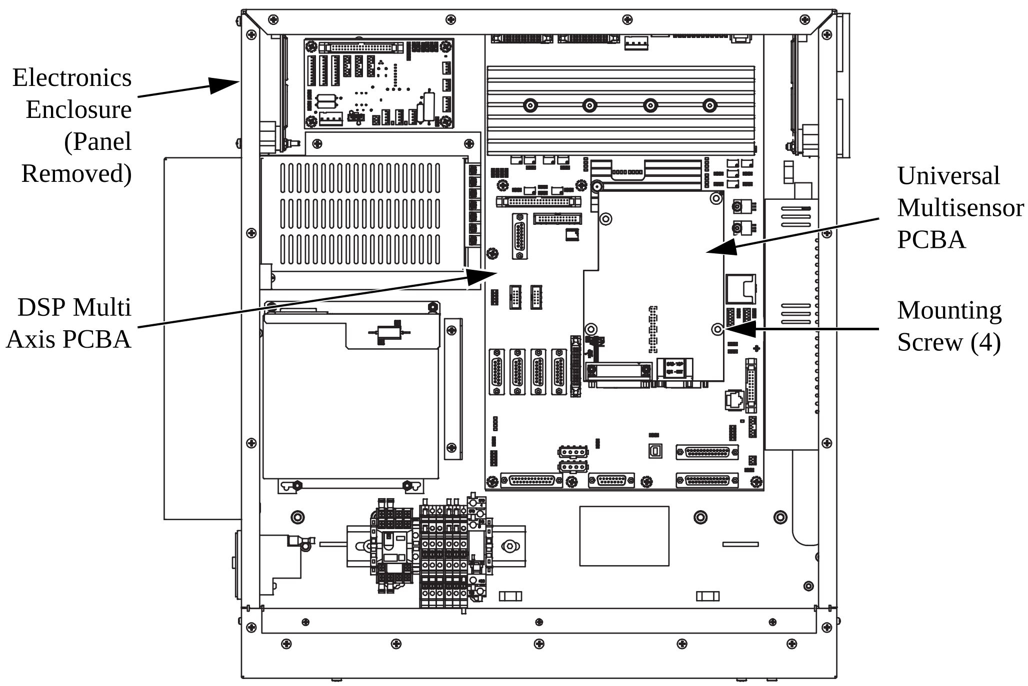


Figure 9-28 Location of the Universal Multisensor PCBA

3. Disconnect all cables from the Universal Multi-Sensor PCBA. If necessary, label the connectors to aid in re-assembly.

4. Use a 2.5 mm Allen wrench to remove the four screws that secure the Universal Multi-Sensor PCBA to the DSP Multi Axis PCBA or Micro Theta Control PCBA.

5. Remove the old Universal Multi-Sensor PCBA from the electronics enclosure and put it in a plastic, anti-static bag.

6. Use the mounting hardware removed in Step 4 to install the replacement Universal Multi-Sensor PCBA.

7. Re-connect all previously disconnected cables.

8. Re-install the electronics enclosure panel.

9. Re-connect the power cord, power up the system, and verify proper system operation.

9.11.6 Replacing the Micro Theta Control PCBA (If Equipped)

Tools Required	Part No.
Phillips-head screwdriver	N/A
Set of Metric hex key (Allen) wrenches	N/A
Plastic, anti-static bag	N/A

1. Shut down the system and disconnect the power cord from the power source.

Warning: Always power down the machine and disconnect the power cord before removing the electronics enclosure panel.

2. Remove the electronics enclosure panel — see ***Removing the Electronics Enclosure Panel*** on page 165.

The Micro Theta Control PCBA is mounted to the DSP Multi Axis PCBA, connected to P400 (see Figure 9-29).

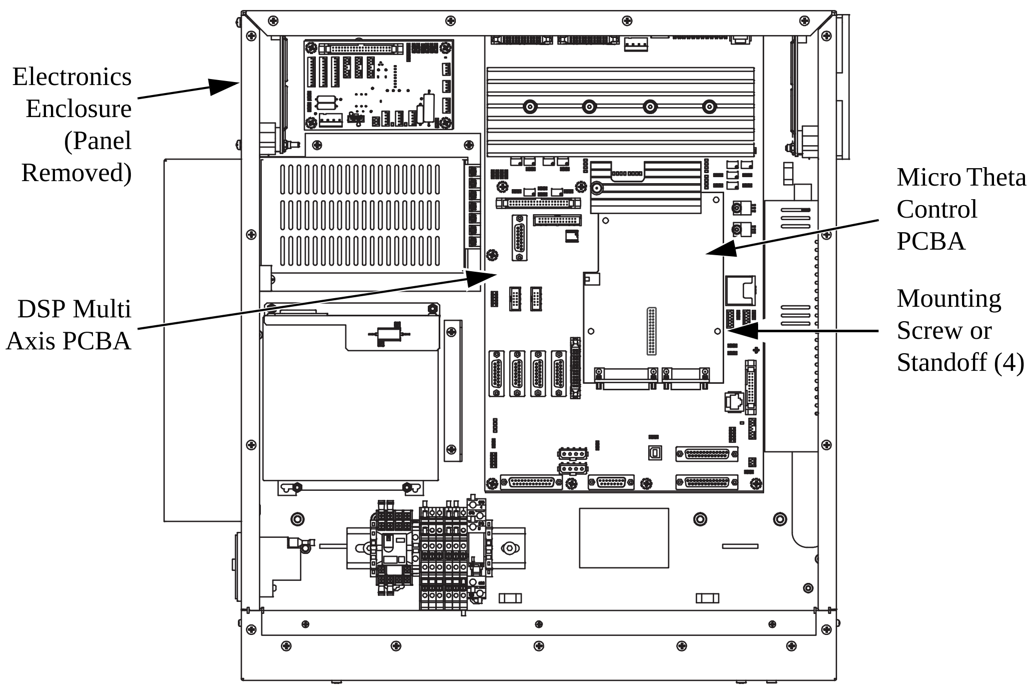


Figure 9-29 Location of the Micro Theta Control PCBA

3. If the system is equipped with the Universal Multi-Sensor PCBA, remove it before continuing — see ***Replacing the Universal Multisensor PCBA (If Equipped)*** on page 204.

4. Disconnect all of the cables from the Micro Theta Control PCBA. If necessary, label the connectors to aid in re-assembly.

5. Use a 2.5 mm Allen wrench to remove the four screws (and washers) that secure the Micro Theta Control PCBA to the DSP Multi Axis PCBA.

Note: If the system is equipped with the Universal Multi-Sensor PCBA, the Micro Theta Control PCBA is mounted to the DSP Multi Axis PCBA with standoffs instead of screws.

---

6. Remove the old Micro Theta Control PCBA from the electronics enclosure and put it in a plastic, anti-static bag.

7. Use the mounting hardware removed in Step 4 to install the replacement Micro Theta Control PCBA.

8. If the system is equipped with the Universal Multi-Sensor PCBA, re-install it using the mounting hardware retained during disassembly.

9. Re-connect all previously disconnected cables.

10. Re-install the electronics enclosure panel.

11. Re-connect the power cord, power up the system, and verify proper system operation.

9.12 Replacing the Power Supplies

Caution: Protect the machine from electrostatic damage. Perform these procedures in a static-free area and wear a ground strap. If a ground strap is not available, follow these guidelines:

- Work in an uncarpeted area.
- Discharge static electricity before touching electronic components by touching a known grounded object.

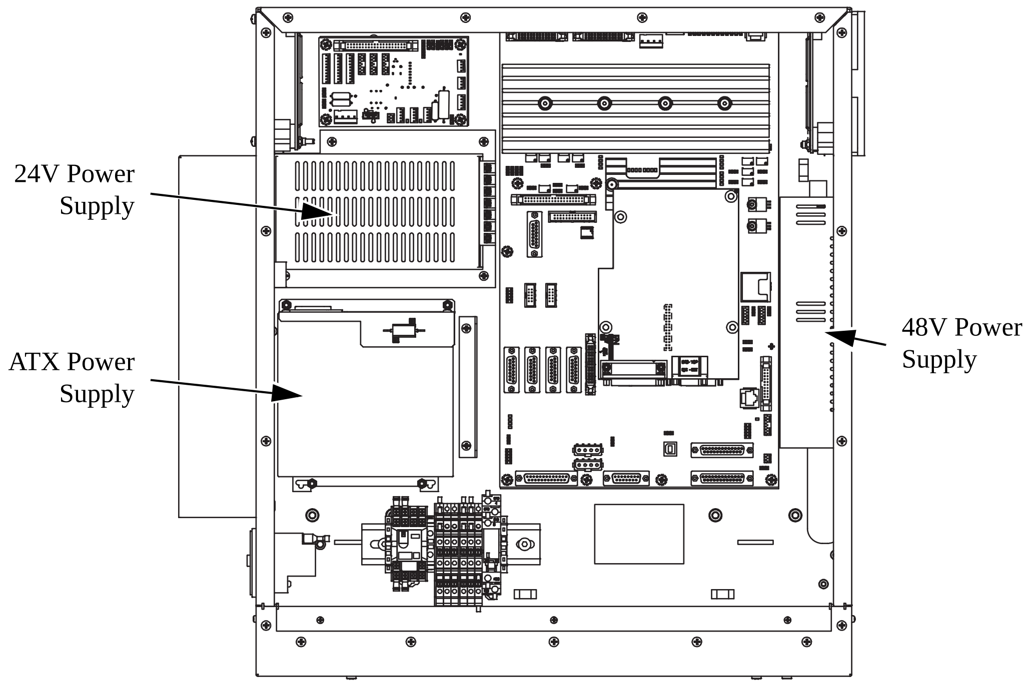


Figure 9-30 Location of Benchmark 450 Power Supplies

9.12.1 Replacing the 24 Volt Power Supply

Tools Required	Part No.
Phillips-head screwdriver	N/A
Set of Metric hex key (Allen) wrenches	N/A
Wire cutters	N/A
Cable-ties	N/A

1. Shut down the system and disconnect the power cord from the power source.

Warning: Always power down the machine and disconnect the power cord before removing the electronics enclosure panel.

2. Remove the electronics enclosure panel — see ***Removing the Electronics Enclosure Panel*** on page 165.

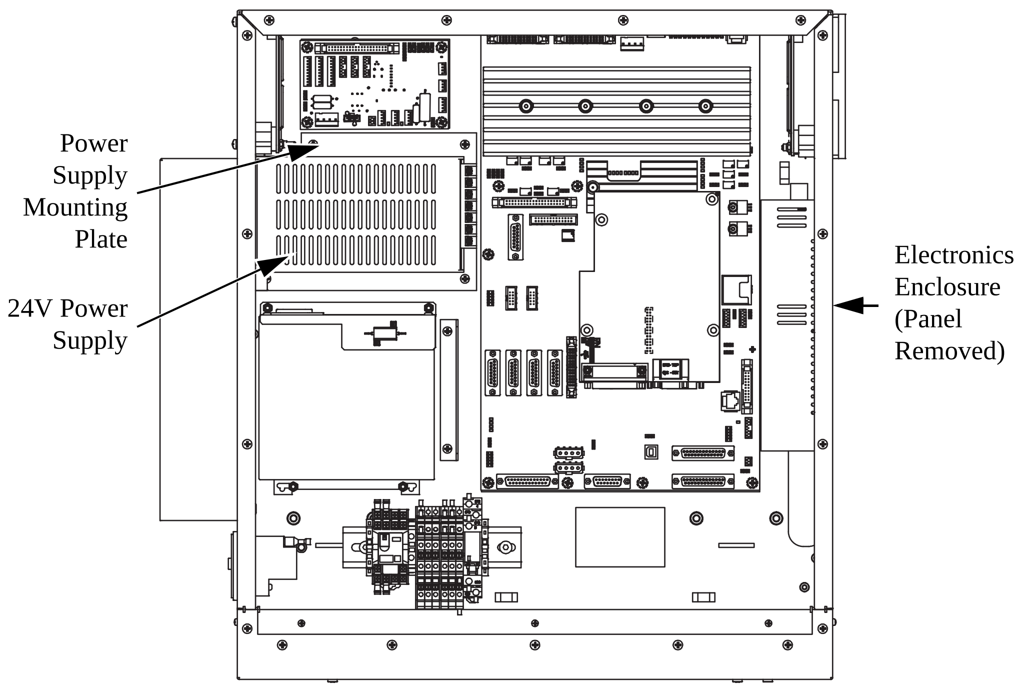


Figure 9-31 Location of the 24V Power Supply

3. Trace the 24V power supply cables to the various power supply connectors and free the cables by cutting the cable-ties.

Caution: If any of the cables are not labeled, make and attach labels before disconnecting them. Connecting power supply cables to the wrong connectors could cause permanent damage to the power supply and/or other components.

4. Disconnect all power supply connectors.

5. While supporting the 24V power supply, use a Phillips-head screwdriver to remove the four screws that secure the power supply mounting plate (and attached power supply) to the electronics enclosure. Retain all mounting hardware.

6. Remove the 24V power supply from the electronics enclosure.

7. Remove the mounting plate from the old power supply (see Figure 9-32) and install it onto the replacement power supply.

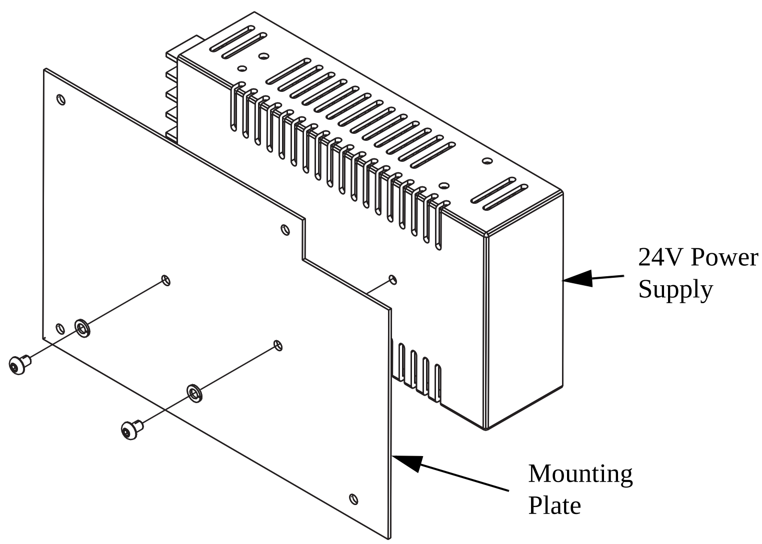


Figure 9-32 Removing the Mounting Plate from the 24V Power Supply

8. Replace the old 24V power supply with the replacement power supply.
9. Use the mounting hardware removed in Step 5 to secure the mounting plate (and attached power supply) to the electronics enclosure.
10. Re-connect all previously disconnected power supply cables.
11. Replace all previously removed cable-ties.
12. Re-install the electronics enclosure panel.
13. Re-connect the power cord, power up the system, and verify proper system operation.

9.12.2 Replacing the 48 Volt Power Supply

Tools Required	Part No.
Phillips-head screwdriver	N/A
Wire cutters	N/A
Cable-ties	N/A

1. Shut down the system and disconnect the power cord from the power source.

Warning: Always power down the machine and disconnect the power cord before removing the electronics enclosure panel.

2. Remove the electronics enclosure panel — see ***Removing the Electronics Enclosure Panel*** on page 165.

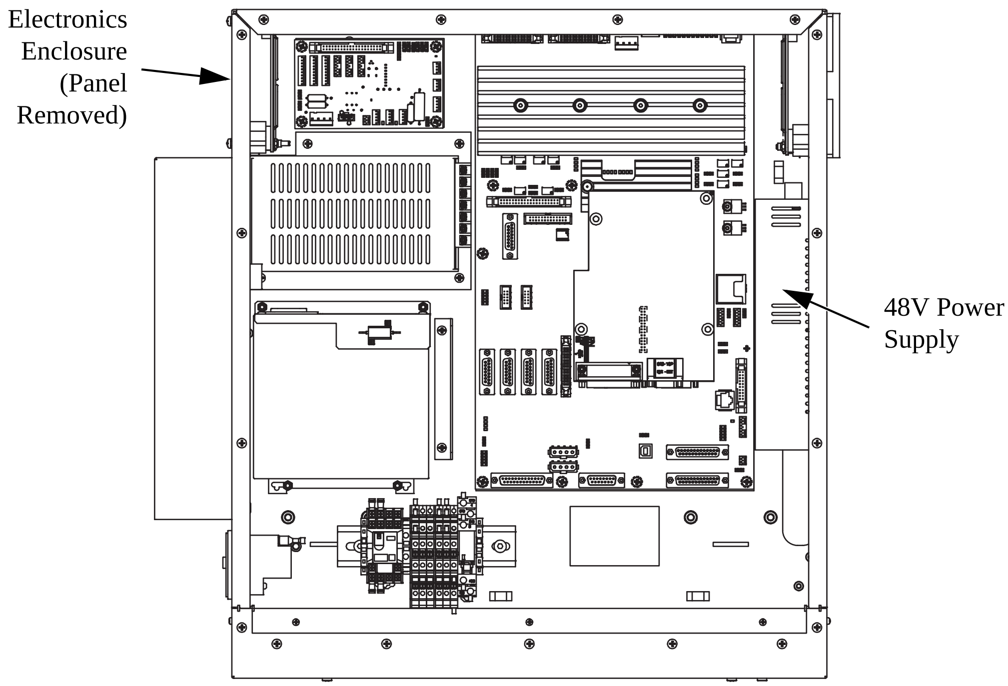


Figure 9-33 Location of the 48V Power Supply

3. Trace the 48V power supply cables to the various power supply connectors and free the cables by cutting the cable-ties.

Caution: If any of the cables are not labeled, make and attach labels before disconnecting them. Connecting power supply cables to the wrong connectors could cause permanent damage to the power supply and/or other components.

4. Disconnect all of the power supply connectors.

5. While supporting the 48V power supply, use a Phillips-head screwdriver to remove the four screws that secure the power supply mounting plate (and attached power supply) to the electronics enclosure. Retain all mounting hardware.

6. Remove the 48V power supply from the electronics enclosure.

7. Remove the mounting plate from the old power supply (see Figure 9-32) and install it onto the replacement power supply.

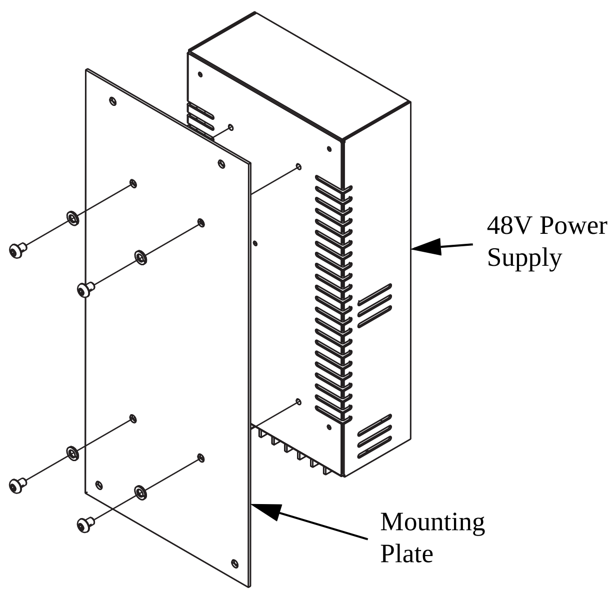


Figure 9-34 Removing the Mounting Plate from the 48V Power Supply

8. Use the mounting screws removed in Step 5 to secure the power supply mounting plate (and attached power supply) to the electronics enclosure.

9. Re-connect all previously disconnected power supply cables.

10. Replace all previously removed cable-ties.

11. Re-install the electronics enclosure panel.

12. Re-connect the power cord, power up the system, and verify proper system operation.

9.12.3 Replacing the ATX Power Supply

Tools Required	Part No.
Phillips-head screwdriver	N/A
4 mm socket wrench	N/A
Ribbon cable clips (2)	N/A
Wire cutters	N/A
Cable-ties	N/A

1. Shut down the system and disconnect the power cord from the power source.

Warning: Always power down the machine and disconnect the power cord before removing the electronics enclosure panel.

2. Remove the electronics enclosure panel — see ***Removing the Electronics Enclosure Panel*** on page 165.

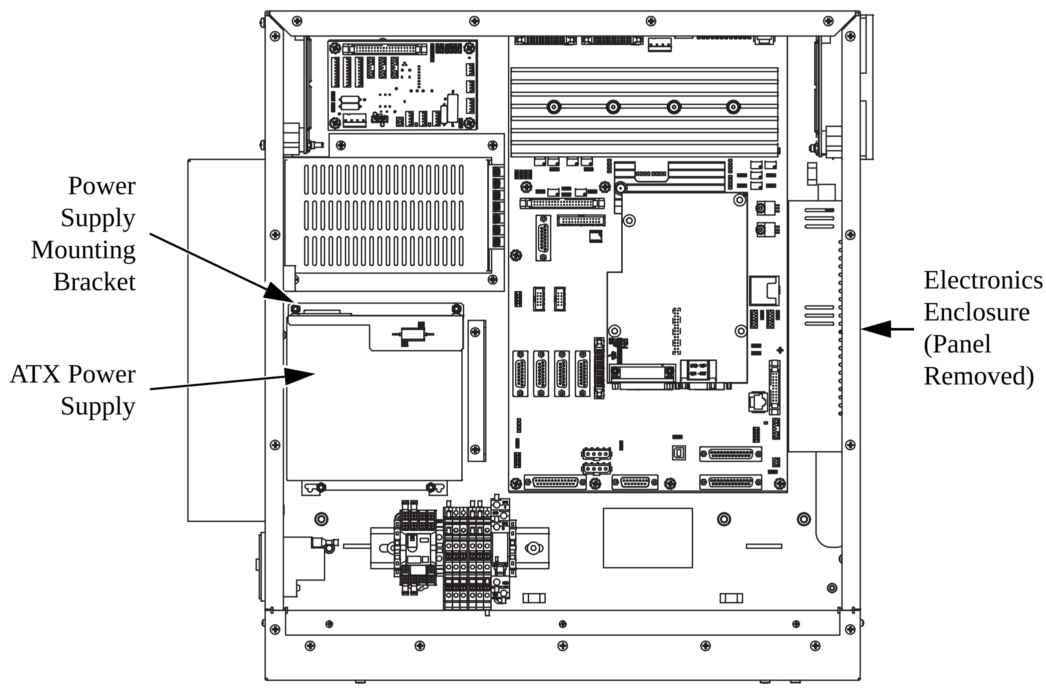


Figure 9-35 Location of the ATX Power Supply

3. Trace the ATX power supply cables to the various power supply connectors and free the cables by cutting the cable-ties.

Caution: If any of the cables are not labeled, make and attach labels before disconnecting them. Connecting power supply cables to the wrong connectors could cause permanent damage to the power supply and/or other components.

4. Disconnect all of the power supply connectors, and then disconnect the power plug from the power supply.

5. Remove the ribbon cables from the ribbon cable clamps attached to the power supply.

6. While supporting the ATX power supply, use a 4 mm socket wrench to remove the four lock nuts that secure the power supply mounting bracket and power supply to the electronics enclosure. Retain all mounting hardware.

7. Remove the ATX power supply from the electronics enclosure.

8. Remove the load resistor bracket (and attached load resistor) from the old power supply (see Figure 9-36) and install it on the replacement power supply.

9. Remove the mounting bracket from the old power supply (see Figure 9-36) and install it onto the replacement power supply.

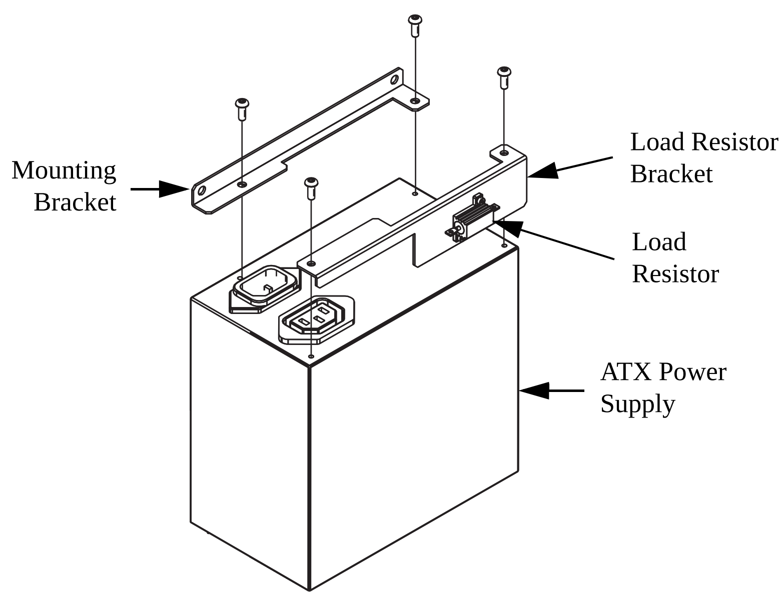


Figure 9-36 Removing the Load Resistor and Mounting Brackets from the ATX Power Supply

10. Attach two new ribbon cable clamps to the replacement power supply. Use the old power supply for reference.

11. Use the mounting hardware removed in Step 6 to install the replacement power supply.

12. Re-connect all previously disconnected power supply cables.

13. Replace all previously remove cable-ties.

14. Re-install the electronics enclosure panel.

15. Re-connect the power cord, power up the system, and verify proper system operation.

9.13 Replacing the Fans

The Benchmark 450 system has two main fan assemblies:

- An exhaust fan is mounted to the left interior wall of the electronics enclosure.
- An intake fan is mounted to the right interior wall of the electronics enclosure.

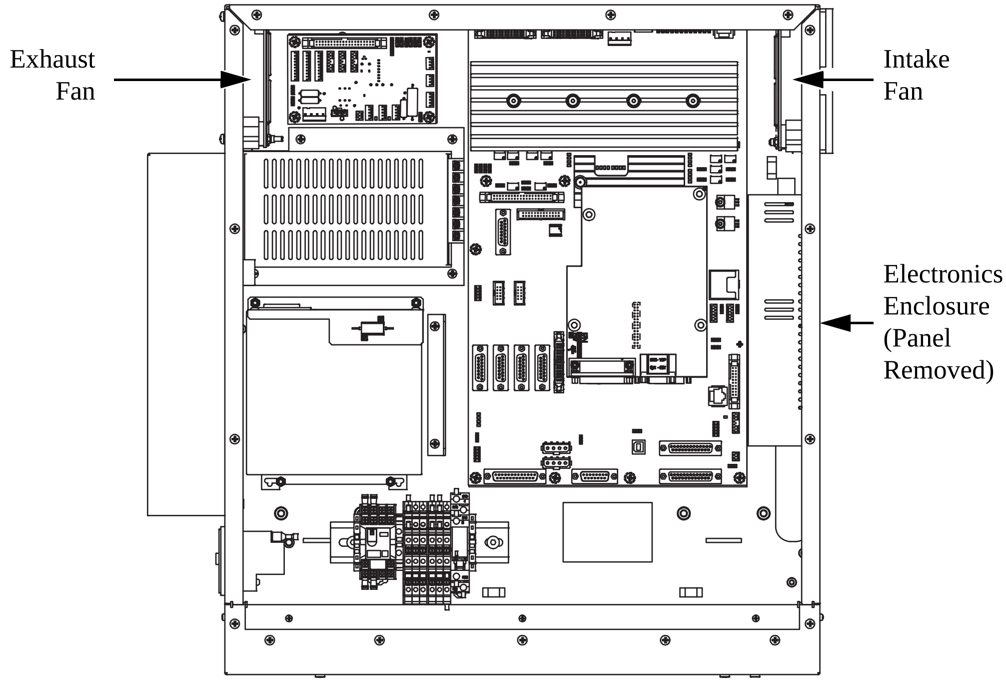


Figure 9-37 Location of the Benchmark 450 Fan Assemblies

9.13.1 Replacing the Exhaust Fan

Tools Required	Part No.
Phillips-head screwdriver	N/A
Adjustable crescent wrench	N/A

1. Shut down the system and disconnect the power cord from the power source.

Warning: Always power down the machine and disconnect the power cord before removing the electronics enclosure panel.

2. Remove the electronics enclosure panel — see ***Removing the Electronics Enclosure Panel*** on page 165.

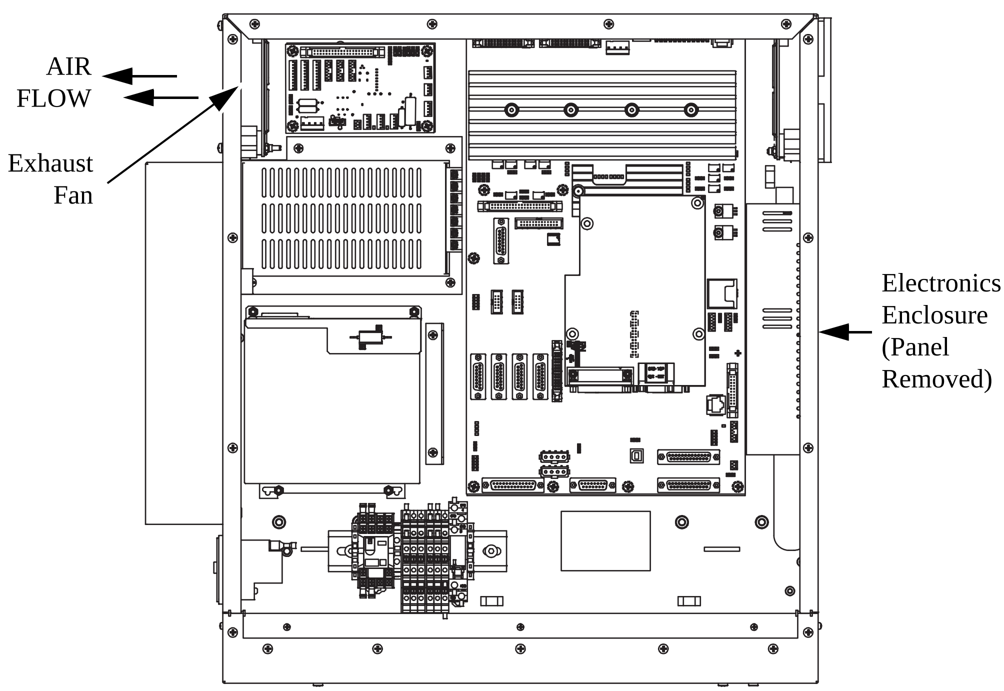


Figure 9-38 Location of the Exhaust Fan

3. Unplug the fan power connector from the exhaust fan.

4. While supporting the fan, use a Phillips-head screwdriver and an adjustable crescent wrench to remove the fan mounting screws, hex nuts, and metal finger guard (see Figure 9-39). Retain all mounting hardware.

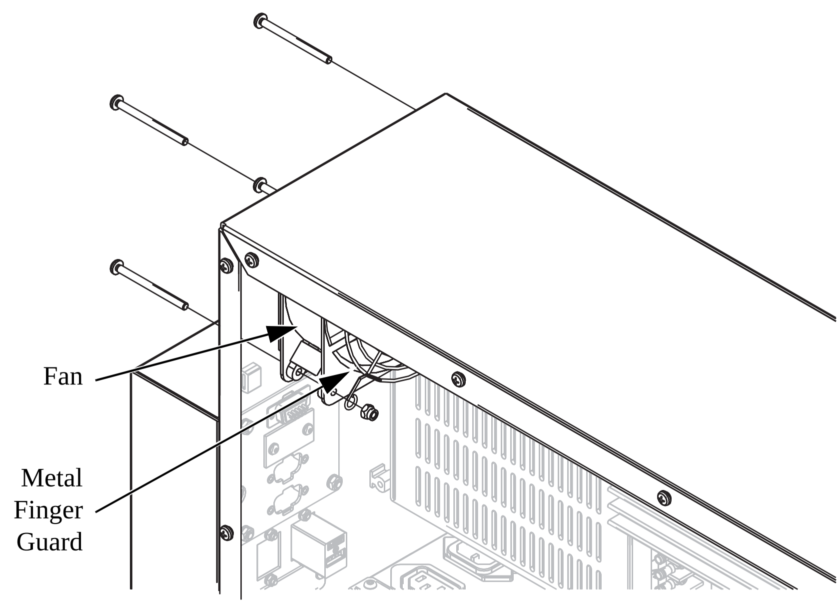


Figure 9-39 Removing the Exhaust Fan

5. Remove the fan and metal finger guard from the electronics enclosure.

6. Use the mounting hardware removed in Step 4 to install the replacement exhaust fan and metal finger guard.

7. Re-connect the fan power cord so the red wire (the positive side) lines up with the positive plug on the fan. **Do not reverse polarity!**

8. Re-install the electronics enclosure panel.

9. Re-connect the power cord, power up the system, and verify that the airflow is in the direction indicated by the arrows in Figure 9-38.

9.13.2 Replacing the Intake Fan

Tools Required	Part No.
Phillips-head screwdriver	N/A
Flat-head screwdriver	N/A
Adjustable crescent wrench	N/A

1. Shut down the system and disconnect the power cord from the power source.

Warning: Always power down the machine and disconnect the power cord before removing the electronics enclosure panel.

2. Remove the electronics enclosure panel — see ***Removing the Electronics Enclosure Panel*** on page 165.

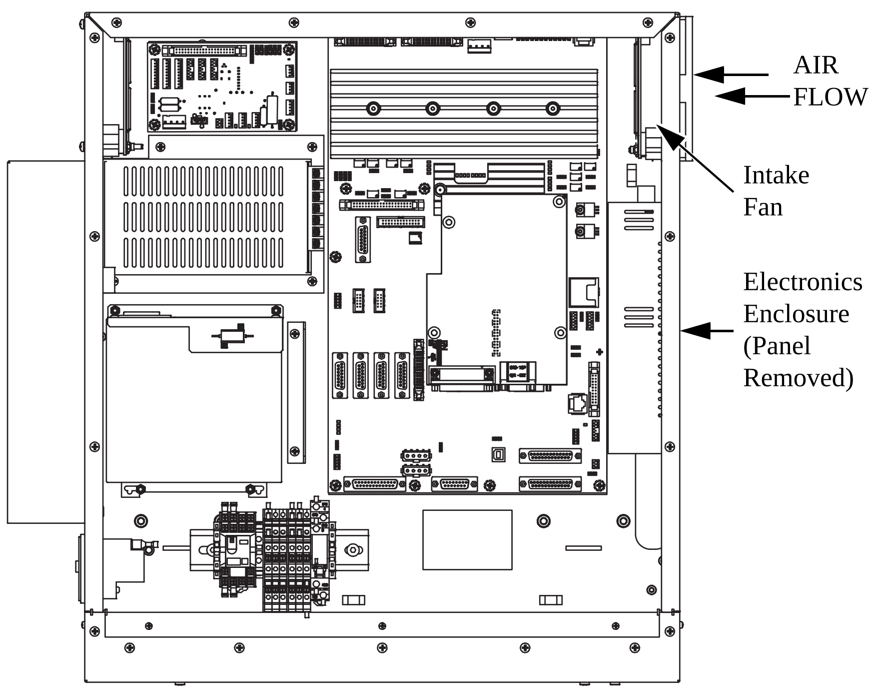


Figure 9-40 Location of the Intake Fan

3. Unplug the fan power connector from the exhaust fan.

4. Use a flat-head screwdriver (or similar tool) to remove the filter retainer and foam filter from the plastic finger guard on the outside of the electronics enclosure (see Figure 9-41).

5. While supporting the fan, use a Phillips-head screwdriver and an adjustable crescent wrench to remove the fan mounting screws, hex nuts, metal finger guard, and plastic finger guard (see Figure 9-41). Retain all mounting hardware.

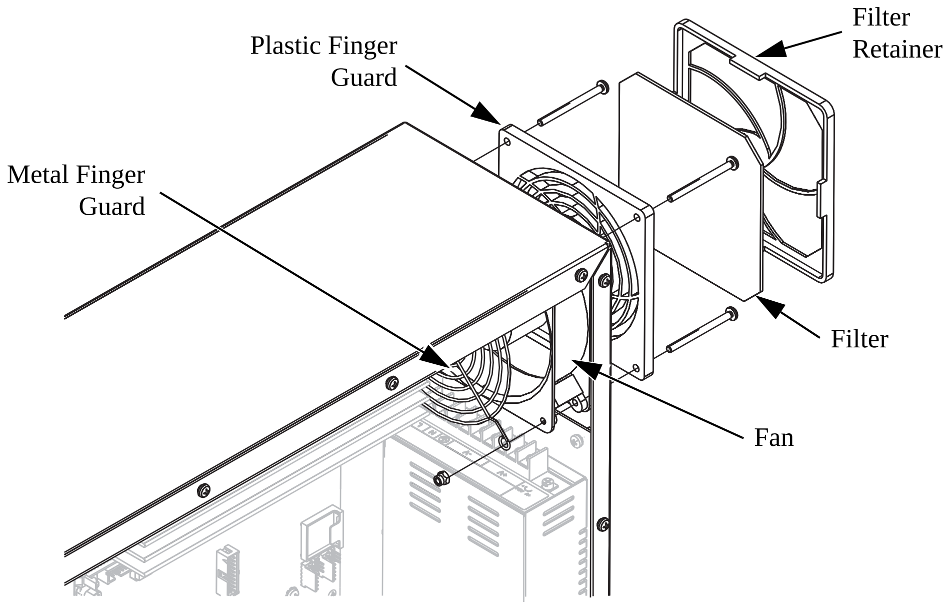


Figure 9-41 Removing the Intake Fan

6. Remove the fan and metal finger guard from the electronics enclosure.

7. Use the mounting hardware removed in Step 5 to install the replacement intake fan, metal finger guard, and plastic finger guard.

8. Re-connect the fan power cord so the red wire (the positive side) lines up with the positive plug on the fan. **Do not reverse polarity!**

9. Re-install the electronics enclosure panel.

10. Re-connect the power cord, power up the system, and verify that the airflow is in the direction indicated by the arrows in Figure 9-40.

VMS System Certification & Verification 7.02

Appendix A

A.1 What This Appendix Contains

This appendix covers the following:

- General Guidelines
- Handling & Cleaning Grid Plates, Scales, & Lenses
- Wringing Gage Blocks
- System Certification
- System Verification

This appendix is intended to help you perform an accurate X-, Y-, and Z-axis certification and/or verification of the Benchmark 450 system. It outlines the equipment required and the steps necessary to properly complete an accurate system certification and/or system verification using the VMS certification software.

A.2 General Guidelines

- The system must have the Ronchi Grid Autofocus capability; if not, run Certification & Verification 5.3.
- The Benchmark 450 system requires an application-specific program and an NIST-traceable artifact to properly certify and/or verify the system.
- By performing these procedures, you will create an essential error map and test that error map after it has been created. This error map, created and used by the VMS software, is named `LOOKUP.TBL`.
- We recommend that you calibrate the system annually to assure accurate and repeatable measurement results.

A.3 Handling & Cleaning Grid Plates, Scales, & Lenses

Caution: The chrome surface on the grid plates and scales should never be touched by hand near the area of the grid lines.

Grid plates should only be handled with minimal contact (perimeter only) of the chrome surface. Oil from your hands is corrosive and the scales and plates can be damaged when you attempt to clean them. Grid lines are typically fifty microns wide and scale tick marks are typically thirty microns wide—even a small scratch can cause an error of a couple of microns. Use only a soft hair brush, lens tissue and lens cleaner to gently clean a lens, scale or grid plate. Any other materials or improper handling can damage these artifacts. Use the brush first to remove loose contamination. If you have any questions about how to handle or clean these artifacts, contact the Customer Support HelpDesk (see ***Where to Get Help*** on page 4).

A.4 Wringing Gage Blocks

Caution: Gage Blocks and accessories manufactured from croblox (Chromium-carbide) are harder but more brittle than gage blocks made from regular hardened tool steel. These gage blocks may be expected to give more than 10 times the wear-life over steel gage blocks, but *extreme care should be taken in their use and handling*.

- NEVER ALLOW THESE GAGE BLOCKS TO HIT EACH OTHER. If nicked, the surfaces may chip or become raised and the gage blocks may not be suitable for use. Do not try to assemble combinations of gage blocks above an open set. If they fall into the set, many pieces may be damaged.
- DO NOT OVER-STRESS THE GAGE BLOCKS when taking I.D., O.D., or slot measurements; they may easily break because they are extremely brittle.
- These gage blocks have undergone exhaustive inspection to assure maximum quality and are guaranteed to meet the requirements of Federal Specification GGG-G-15C. However, due to the fragile nature of these materials, we regret to advise that we will not be held responsible for breakage, cracking, or other damage caused by rough handling or misuse.

1. Clean the blocks by applying a small amount of mineral spirits to a clean, soft, lint-free cloth.

2. If the optical surface (i.e., top surface) needs visible spots removed, it can be cleaned with lens cleaner and tissue.

3. Lay another piece of clean, soft, lint-free cloth on a flat, non-absorbent surface.

4. Place two drops of clean, filtered, light oil on one area of the cloth.

5. Take one of the clean blocks; and place it with the measuring face down on the cloth, rubbing it gently in the oiled area.

6. Move the block to an un-oiled section of the cloth, and move it in a figure-eight motion to clean off the excess oil. (When cleaned correctly, the oil should only be visible as a slight discoloration to the block surface.)

7. Slide the gage block with light pressure onto another clean gage block.

8. Wring the block half out of engagement and then back into the matched position in a circular motion.

9. Continue this wringing procedure until the desired setup is complete.

Note: With practice, wringing gage blocks becomes second nature. To check your skill level while learning, wring a 1-inch block and a 2-inch block together. After letting them "soak" back (or return) to ambient temperature, compare the setup to a 3-inch block with a system using a field of view (FOV) of ~1.5mm and a grid.

A.5 System Certification

The XY Certify procedure detects measurement error and stores it in a table to be used for correction. Depending on the default machine type selected during the certification process, the system will measure the grid plate in one of two ways:

- By measuring an entire row (from -X to +X) five times, and then indexing in the -Y direction and measuring the remaining rows on the grid plate — in this case, the primary moving axis is the X-axis
- By measuring an entire column (from +Y to -Y) five times, and then indexing in the +X direction and measuring the remaining columns on the grid plate — in this case, the primary moving axis is the Y-axis

The results are averaged and the raw, uncorrected, measured distances (in X and Y) of each intersection from the center intersection are rotated to match the measured data more closely. That data is then compared to the “known” certified distances, and the difference is the detected error at that location on the stage. That error is saved in the lookup (correction) table with a resolution of 1/10 micron.

The Z Certify measurements and derived performance statistics are similar with some exceptions; see ***Z Certification*** on page 235.

Tools Required
XY grid plate and data file
Z-axis step gage and data file or Z-axis gage-block fixture and data file
1X magnification lens
High magnification lens
Lens calibration standard
Standard set of Allen wrenches
VMS Cert & Verify Program

A.5.1 Certification Setup

1. If necessary, install the VMS Cert & Verify program. This program should be installed into the current VMS directory (e.g., C:\Program Files\VMS).

2. Install a calibrated 1X magnification lens.

3. [XY Certification ONLY] Carefully place the XY grid plate on the worktable. Then secure the XY-axis grid plate by tightening the set screws or retaining clamps at each end of the Y-axis stage. Make sure the grid plate is level to within **±0.01 mm (0.0004")** and is aligned to the XY travel.

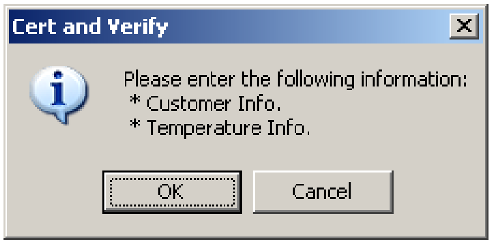
4. [XY Certification ONLY] Use Windows Explorer to copy the associated grid plate data file into the current VMS directory. Then rename the data file to `XYNOM.CRT`.

5. [Z Certification ONLY] Use Windows Explorer to copy the associated Z-axis step gage file into the current VMS directory. Then rename the data file to `ZNOM.CRT`.

6. Exit the VMS software before continuing.

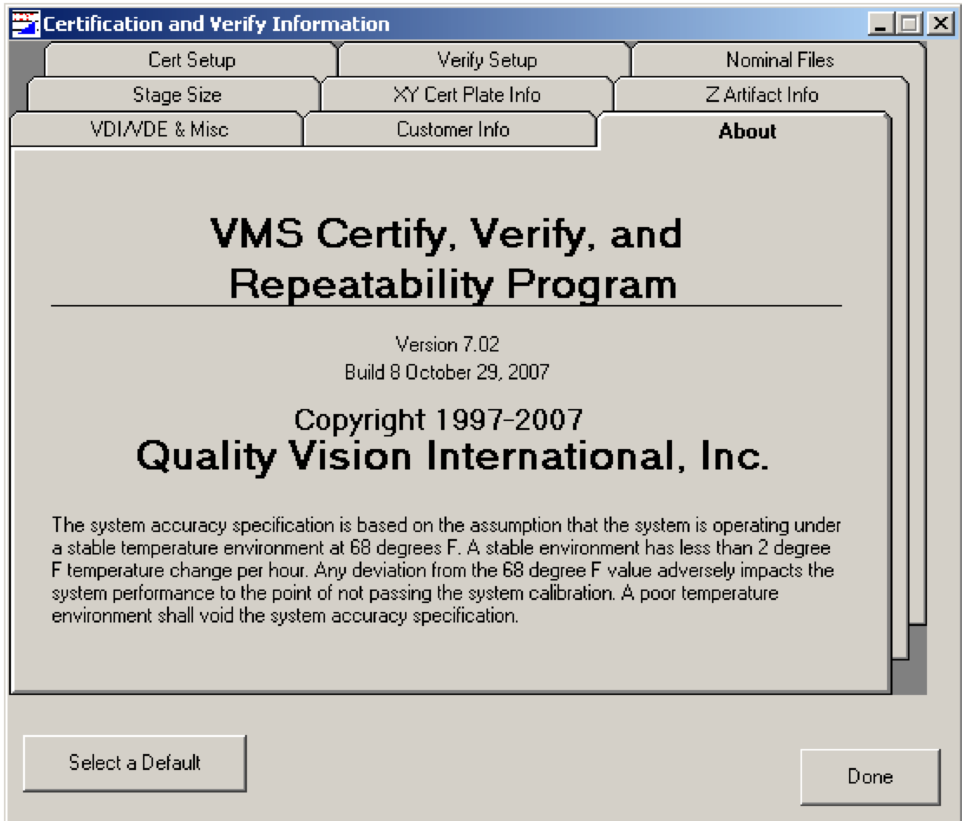
7. Launch the Cert & Verify program by double-clicking on its Desktop icon (`VOYCERT.EXE`).

   The following appears:



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

The following appears:



9. Click **Select a Default** and double-click the system that you are certifying to enter the system specific information into the required fields automatically.

Caution: Be sure to choose the correct system in the default machine type list. If the incorrect default machine type is chosen, the correction factors will be incorrect, and the verification process may not pass after you perform an XY and/ or Z certification.

10. Click the **Customer Info** tab and enter the following information:

- customer
- operator name
- machine & model
- machine serial number

11. Click the **VDI/VDE & Misc** tab.

12. Click the **Manual (deg F)** radio button and enter the current room temperature in the **Temperature** box.

Note: Some systems are set up to automatically read and record ambient temperature. If this is the case for your system, we recommend that you click the **Auto** radio button to record the temperature automatically.

---

13. [XY Certification ONLY] Click the **Scan rows before columns** radio button.

Note: If you want to measure the entire plate before repeating a row, select the **Inspect entire plate before repeating row or column** checkbox.

---

14. [XY Certification ONLY] Click the **Nominal Files** tab and do the following:

- Click the **View style** radio button.
- Browse for and select the `XYNOM.CRT` nominal file.
- Select the appropriate measurement units (must match the nominal file).

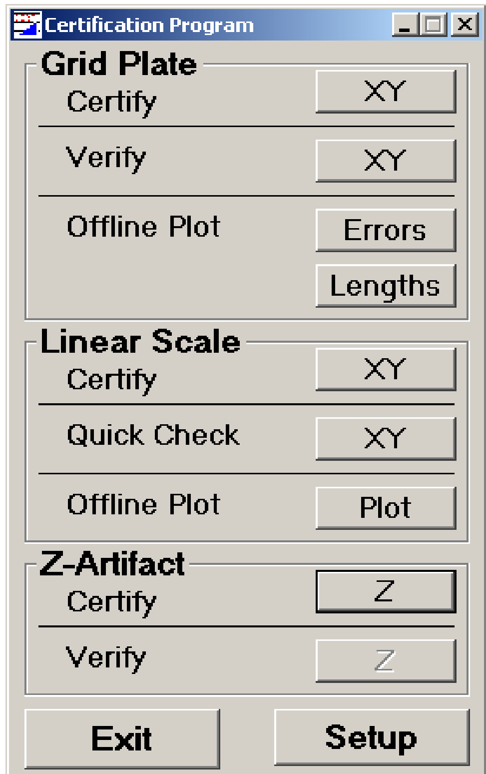
15. [XY Certification ONLY] Click the **XY Cert Plate Info** tab and enter the following information:

- P.O. number of the plate — all digits must match the `XYNOM.CRT` file
- serial number of the plate — leading zeros are ignored
- number of unreachable lines (if any) on each side of the plate

16. [Z Certification ONLY] Click the **Z Artifact Info** tab. Then enter the Artifact set # (must match the `ZNOM.CRT` file) and select the **Gage Blocks** radio button or the **Step Gage** radio button, depending on which method you will be using to certify the Z-axis. Then enter the correct offset information.

17. After all the parameters have been set and the customer information has been updated, click **Done**.

The following appears:



You are now ready to perform an XY Certification (see ***XY Certification*** on page 231) or a Z Certification (see ***Z Certification*** on page 235).

Caution: Do not close the Certification Program window. Doing so will require you to re-enter customer and temperature information.

A.5.2 XY Certification

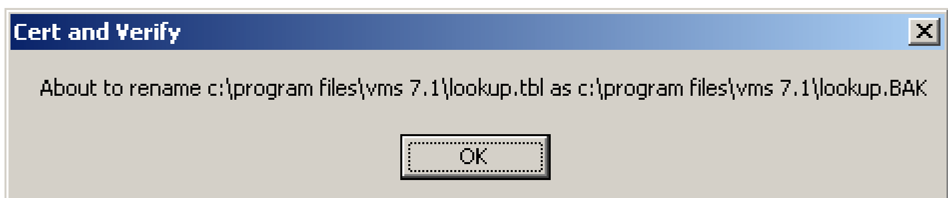
1. Perform the Certification Setup procedure on page 227.

2. Click the Certify **XY** button.

   Something similar to the following appears:

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

   Something similar to the following appears:



Note: A window may appear excluding a number of lines from the top and right sides of the plate. This is normal, click **OK**.

---

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

   The Cert & Verify program automatically launches the VMS software and the following appears:

5. Make sure the E-Stops are pulled out, and then press the **Stop/Start** button on the joystick. Wait for the VMS software to launch, and then click **Continue** in the Certification Program instruction window.

6. Verify that the stages are clear to move, and then click **Continue** in the Certification Program instruction window to zero the stages.

7. Wait for the stages to stop moving and observe the Ready/Not-Zeroed status display switch to *Ready*. Then click **Continue** in the Certification Program instruction window.

Note: If you are prompted to *select OK*, do not press Enter on the keyboard — doing so will be interpreted as a "cancel" instruction in the program. Instead, click **OK** with the mouse.

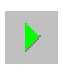
Caution: You may receive the following message:

The lens used by this program is not mounted. The wrong lens may be in use.

This error message is normal and is a precaution. Check and make sure you are using the correct lens. If the lens is correct, click **OK** and continue with this procedure. If the wrong lens is installed, abort the certification process and install and calibrate the correct lens before restarting.

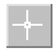
Note: If a warning appears for lighting configuration, click **OK**.

Caution: As the program loads, a number of screens may appear and then disappear. This is normal; do not press any keys or mouse buttons while the program loads, unless prompted to do so.

8. Click  in the VMS toolbar.

9. Adjust the coaxial light intensity so you can image and focus the 0/0 intersection at the center of the XY grid plate.

a. Use the joystick to drive the stages so the 0/0 intersection (see Figure A-1) appears in the Video window.

b. Click  in the Video Window toolbar and center the Crosshair Finder over the 0/0 intersection. Then focus the intersection.

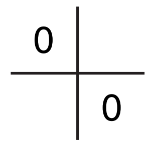


Figure A-1 0/0 intersection

c. Align the plate so it is parallel to the X travel, assuring full travel and good focus in both X and Y directions; adjust the plate height if needed. Full travel assumes that, during the entire Cert and Verify process, all outer intersections (except those excluded in the setup) used in `XYNOM.CRT` can be imaged.

d. After the plate has been aligned, re-position the Crosshair Finder over the 0/0 intersection.

e. Focus again.

Caution: Before clicking Set Home in the next step, be aware that the stages will return to this location when you click Go Home.

f. Click **Set Home** to establish the current XYZ position as the home position.

10. After all alignments are complete and the XY grid plate is secure, click **OK** in the Autofocus Finder window.

Caution: Before clicking Go Home in the next step, make sure it is safe for the stages to move.

11. The stages may have moved to a preset position in the program. Click **Go Home** to drive the stages to the home position you defined earlier.

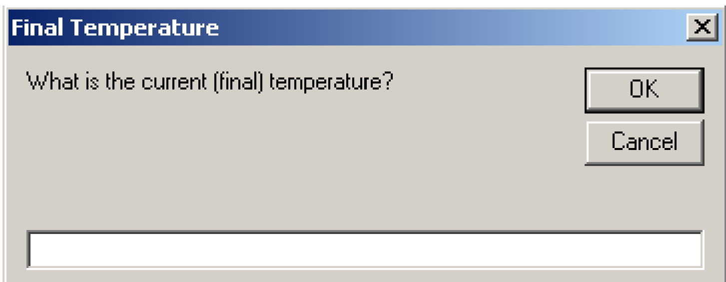
12. Double-click in the Video window.

13. Click  to store the position and begin the certification process.

Note: Light levels are adjusted automatically. If the system cannot converge on a light level, a prompt will appear for the user to select a coaxial light level manually. Record the number, and then enter the value at the prompt.

Note: A status bar that shows the progress of the Certification program appears in the instruction window.

When the certification process is complete, the following appears:



14. Enter the current room temperature and click **OK**.

The file `LOOKUP.TBL` is created in the current VMS directory. This is the actual error map file used during measurement.

15. Exit the Cert & Verify program and the VMS software.

16. Perform the XY Verification procedure on page 250.

A.5.3 Z Certification

Note: Although you can use a Z-axis step gage or a Z-axis gage block fixture and gage blocks to perform the Z certification, we recommend using a step gage.

Note: Use the highest available magnification lens to perform the Z certification.

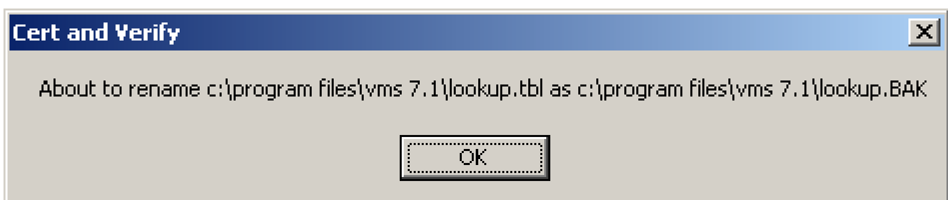
A.5.3.1 Z Certification with a Step Gage

1. Perform the Certification Setup procedure on page 227.

2. Install the highest available magnification lens.

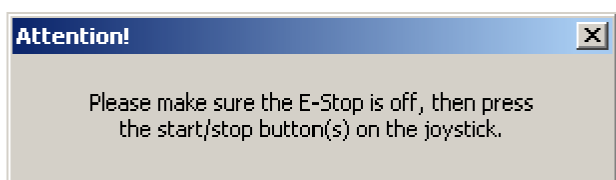
3. Click the Certify **Z** button.

The following appears:



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

The Cert & Verify program automatically launches the VMS software and the following appears:



5. Make sure the E-Stops are pulled out, and then press the **Stop/Start** button on the joystick.

6. Wait for the VMS software to launch, and then click **Continue** in the Certification Program instruction window.

7. Verify that the stages are clear to move and then click **Continue** in the Certification Program instruction window to zero the stages.

8. Wait for the stages to stop moving and observe the Ready/Not-Zeroed status display switch to *Ready*. Then click **Continue** in the Certification Program instruction window.

9. Temporarily mount the Z-axis step gage on the worktable as shown in Figure A-2. Make sure:

- the step gage steps ascend toward you when you are standing in front of the machine
- the step gage is placed toward the front of the worktable
- the step gage is visually square in the X and Y directions
- the step gage is secure on the worktable and will not move during the certification process

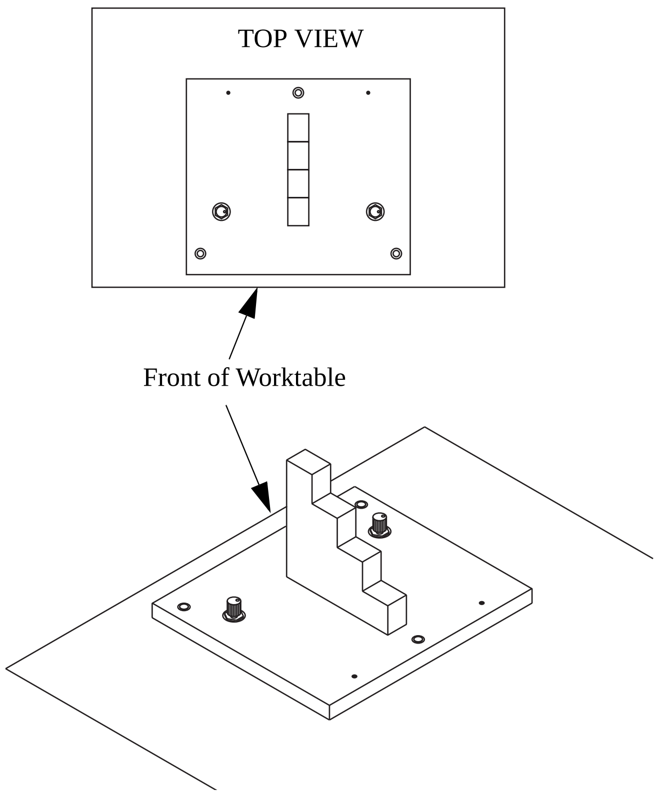


Figure A-2 Mounting the Step Gage on the Worktable

10. Level the step gage to within **±0.002 mm (0.00008")**.

a. Use the joystick to drive the stages so focus point ❶ (see Figure A-3) appears in the Video window.

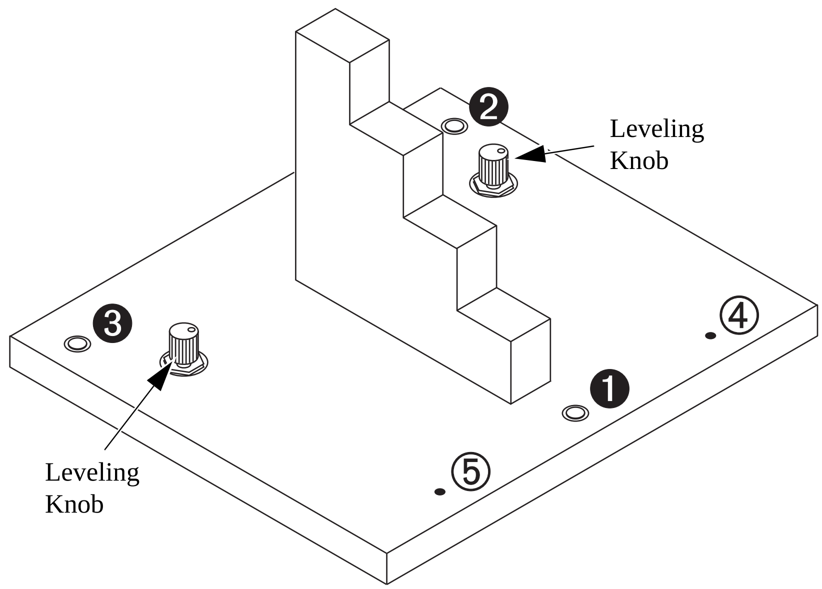
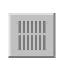
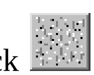


Figure A-3 Leveling the Step Gage

b. Click  in the Video Window toolbar, and then click  in the Autofocus Settings window to select the Textured Surface Focus tool.

c. Select the High Mag camera and perform an autofocus on focus point ❶.

d. Right-click in the DRO window and select **Zero DRO** in the context menu.

e. Drive the stages so focus point ❷ (see Figure A-3) appears in the Video window

f. Perform an autofocus on focus point ❷.

The Z value in the DRO window should be zero or very close to zero.

– If the Z value for focus point ❷ is within ±0.002 mm (0.00008") of the Z value for focus point ❶, no adjustment is required; go to Step 10i.

– If the Z value is not within ±0.002 mm (0.00008"), use the leveling knob adjacent to focus point ❷ to level the step gage; continue with the next step.

g. Repeat Steps 10a through 10f.

h. Drive the stages so focus point ❸ (see Figure A-3) appears in the Video window.

i. Perform an autofocus on focus point ❸. Again, the Z value in the DRO window should be zero or very close to zero.

- If the Z value for focus point ❸ is within ±0.002 mm (0.00008") of the Z value for focus point ❷, no adjustment is required; go to Step 11.
- If the Z value is not within ±0.002 mm (0.00008"), use the leveling knob adjacent to focus point ❸ to level the step gage; continue with the next step.

j. Repeat Steps 10a through 10i as many times as necessary to level the step gage to within ±0.002 mm (0.00008").

11. Set the Joystick Mode to **Slow**.

Note: If you are prompted to *select OK*, do not press Enter on the keyboard — doing so will be interpreted as a "cancel" instruction by the program. Instead, click **OK** with the mouse.

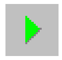
Caution: You may receive the following message:

The lens used by this program is not mounted. The wrong lens may be in use.

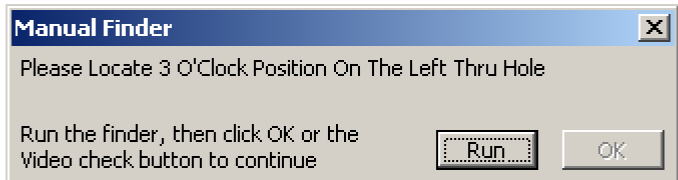
This error message is normal and is a precaution. Check and make sure you are using the correct lens. If the lens is correct, click **OK** and continue with this procedure. If the wrong lens is installed, abort the certification process and install and calibrate the correct lens before restarting.

Caution: As the program loads, a number of screens may appear and then disappear. This is normal. Do not press any keys or mouse buttons while the program loads, unless prompted to do so.

---

12. Click  in the VMS toolbar.

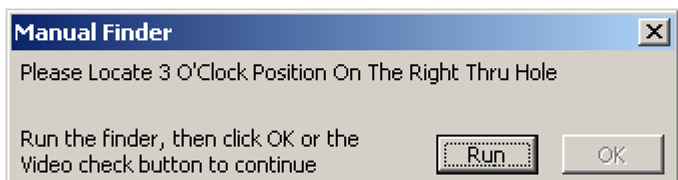
    The following appears:



13. Drive the stages so the left through hole (④ in Figure A-3) appears in the Video window. Then position the Crosshair Finder on the right edge of the hole (3 o'clock position).

14. Click **Run** in the displayed prompt to run the finder, and then click **OK**.

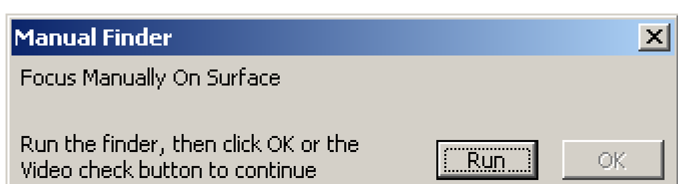
    The following prompt appears:



15. Drive the stages so the right through hole (⑤ in Figure A-3) appears in the Video window. Then position the Crosshair Finder on the right edge of the hole (3 o'clock position).

16. Click **Run** in the displayed prompt to run the finder, and then click **OK**.

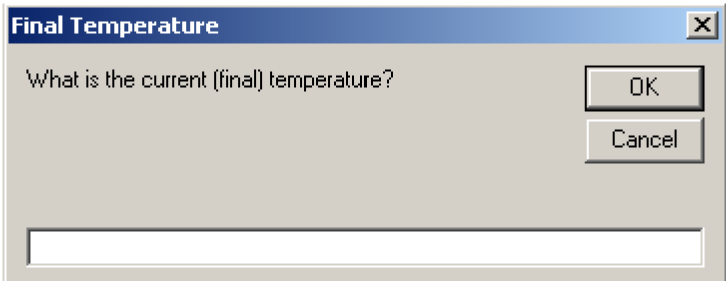
    The system drives to the first step on the step gage, and displays the following:



17. Manually focus the surface of the first step and click **Run** in the displayed prompt to run the finder.

18. Click **OK** to run the Z certification program.

    When the certification process is complete, the following appears:



19. Enter the current room temperature and click **OK**.

    The Certification Program window displays the following:

    Calculating lookup table values .... New Lookup Table created. Press Continue to exit VMS. Changes will take effect when VMS is restarted.

20. Click **Continue**. Additional information will be added to the error map file (`LOOKUP.TBL`).

21. Exit the Cert & Verify program and the VMS software.

22. Perform the Z Verification procedure on page 254.

A.5.3.2 Z Certification with Gage Blocks

Note: The use of gage blocks requires you to place and remove blocks from a base block that is permanently mounted in a fixture.

- If the Z certification is performed at 1-inch intervals, four blocks are used, one at a time, in the 1 through 4-inch range.
- If the Z certification is performed at 1/2-inch intervals, a 1/2-inch bock is used in combination with the four blocks for a 1/2-inch interval Z certification.
- For systems with 6 inches of travel in Z, the 1 and 2-inch blocks are wrung onto the 4-inch block.

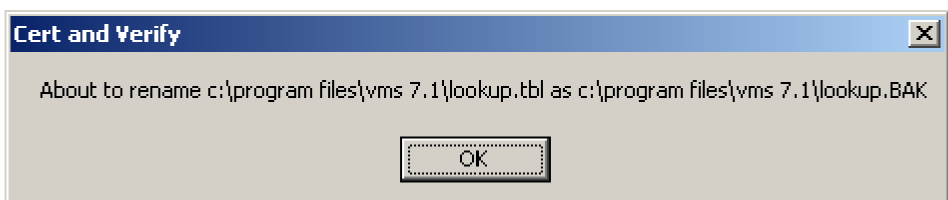
The program automatically drives the Z-axis transport at the appropriate interval during the certification process.

1. Perform the Certification Setup procedure on page 227.

2. Install the highest available magnification lens.

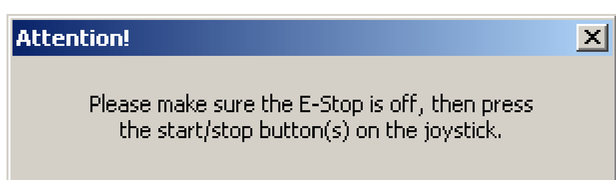
3. Click the Certify **Z** button.

The following appears:



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

The Cert & Verify program automatically launches the VMS software and the following appears:



5. Make sure the E-Stops are pulled out, and then press the **Stop/Start** button on the joystick.

6. Wait for the VMS software to launch and then click **Continue** in the Certification Program instruction window.

7. Move the Certification Program window to the lower-right corner of the screen, so you can see prompts and messages that appear during the certification process.

8. Verify that the stages are clear to move and then click **Continue** in the Certification Program instruction window to zero the stages.

9. Wait for the stages to stop moving and observe the Ready/Not-Zeroed status display switch to *Ready*. Then click **Continue** in the Certification Program instruction window.

10. Temporarily secure the Z-axis fixture to the worktable. The Z-axis fixture is mounted on center, in the X-axis direction.

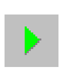
Note: If you are prompted to *select OK*, do not press **Enter** on the keyboard — doing so will be interpreted as a “cancel” instruction by the program. Instead, click **OK** with the mouse.

Caution: You may receive the following message:

The lens used by this program is not mounted. The wrong lens may be in use.

This error message is normal and is a precaution. Check and make sure you are using the correct lens. If the lens is correct, click **OK** and continue with this procedure. If the wrong lens is installed, abort the certification process and install and calibrate the correct lens before restarting.

Caution: As the program loads, a number of screens may appear and then disappear. This is normal. Do not press any keys or mouse buttons while the program loads, unless prompted to do so.

11. Click  in the VMS toolbar.

12. Set the Joystick Mode to **Slow**.

13. Find and focus the upper-right corner of the gage block that is permanently mounted on the fixture (see Figure A-4). You may have to adjust the coaxial light level.

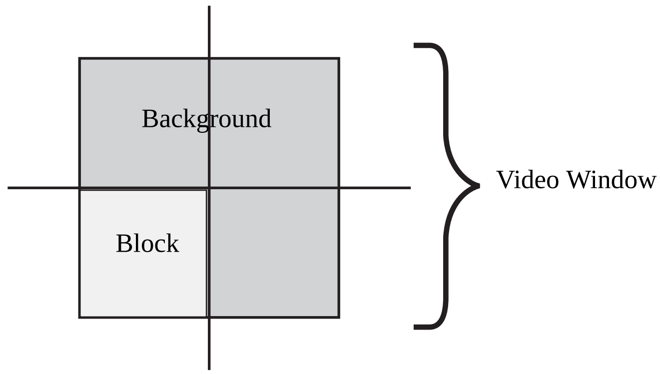
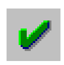


Figure A-4 Crosshair Location, Z-Axis Gage Block

14. Run the Crosshair Finder by double-clicking in the Video window. **Do not click the finder.**

15. Click  to store the position and begin the certification process.

Note: Light levels are adjusted automatically. If the system cannot converge on a light level, a prompt will appear for you to select a coaxial light level manually. Record the number, and then enter the value at the prompt.

- The system performs an autofocus on the base gage block that is permanently mounted on the fixture.
- The Z-axis transport moves up to the next step size in the certification series.

16. Observe the User Input window, and carefully follow the instructions; for example, place a 25.4 mm (1-inch) tall block on the base.

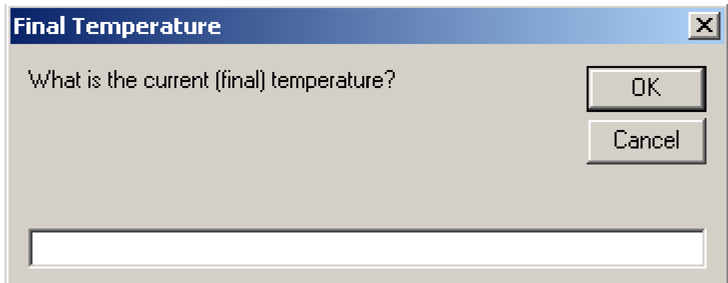
17. Wring in the next gage block; see ***Wringing Gage Blocks*** on page 224.

18. Click **OK**.

19. Observe the Z measurements with Ronchi grid in the User Input window.

20. Repeat Steps 16 through 19 until the certification process is complete.

When the certification process is complete, the following appears:



21. Enter the current room temperature and click **OK**.

The Certification Program window displays the following:

Calculating lookup table values .... New Lookup Table created. Press Continue to exit VMS. Changes will take effect when VMS is restarted.

22. Click **Continue**. Additional information will be added to the error map file (`LOOKUP.TBL`).

23. Remove all stacked gage blocks from the Z-axis fixture, and remove the fixture from the worktable.

24. Exit the Cert & Verify program and the VMS software.

25. Perform the Z Verification procedure on page 254.

A.6 System Verification

For the specifications tested in the XY Verify procedure, the same measurement sequence described in the certification process (see ***System Certification*** on page 226) is used to measure the intersection coordinates again, but this time the lookup table is used to correct the known errors. In the XY Verify procedure, the XY grid plate is measured the number of times specified in the setup. For each intersection, its X and Y distances from the center intersection are measured. These measured distances, or coordinates with respect to the center, will be referred to as *locations*. The locations are passed to the Cert & Verify program for statistical processing, and the results are provided for the desired specifications.

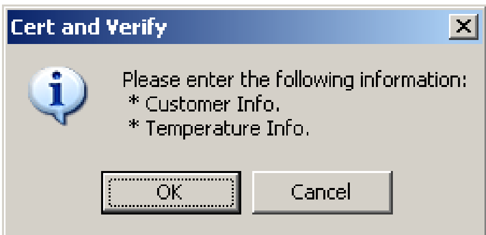
The Z Verify measurements and derived performance statistics are similar with some exceptions; see ***Z Verification*** on page 254.

Tools Required
XY grid plate and data file
Z-axis step gage and data file or Z-axis gage-block fixture and data file
1X magnification lens
High magnification lens
Lens calibration standard
Standard set of Allen wrenches
VMS Cert & Verify Program

A.6.1 Verification Setup

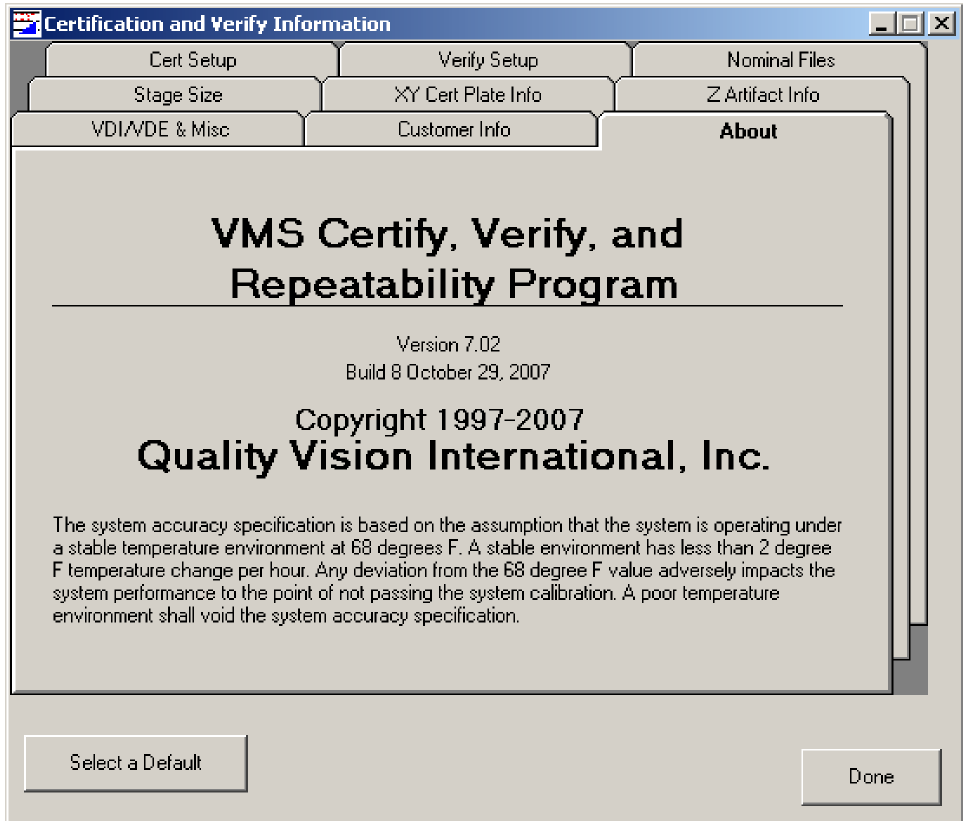
1. If necessary, install the VMS Cert & Verify program. This program should be installed into the current VMS directory (for example, C:\Program Files\VMS).
2. Install a calibrated 1X magnification lens.
3. [XY Verification ONLY] Carefully place the XY grid plate on the worktable. Then secure the XY grid plate by tightening the set screws or retaining clamps at each end of the Y-axis stage. Make sure the grid plate is level to within ±**0.01 mm (0.0004")** and is aligned to the XY travel.
4. [XY Verification ONLY] Use Windows Explorer to copy the associated grid plate data file into the current VMS directory. Then rename the data file to `XYNOM.CRT`.
5. [Z Verification ONLY] Use Windows Explorer to copy the associated Z-axis step gage file into the current VMS directory. Then rename the data file to `ZNOM.CRT`.
6. Exit the VMS software before continuing.
7. Launch the Cert & Verify program by double-clicking on its desktop icon (`VOYCERT.EXE`).

   The following appears:



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

The following appears:



9. Click **Select a Default** and double-click the system that you are verifying to enter the system specific information into the required fields automatically.

Caution: Be sure to choose the correct system in the default machine type list. If the incorrect default machine type is chosen, the correction factors will be incorrect, and the verification process may not pass after you perform an XY and/or Z certification.

10. Click the **Customer Info** tab and enter the following information:

- customer
- operator name
- machine & model
- machine serial number

11. Click the **VDI/VDE & Misc** tab.

12. Click the **Manual (deg F)** radio button and enter the current room temperature in the **Temperature** box.

Note: Some systems are set up to automatically read and record ambient temperature. If this is the case for your system, we recommend that you click the **Auto** radio button to record the temperature automatically.

---

13. [XY Verification ONLY] Click the **Scan rows before columns** radio button.

Note: If you want to measure the entire plate before repeating a row, select the **Inspect entire plate before repeating row or column** checkbox.

---

14. [XY Verification ONLY] Click the **Nominal Files** tab and do the following:

- Click the **View style** radio button.
- Browse for and select the `XYNOM.CRT` nominal file.
- Select the appropriate measurement units (must match the nominal file).

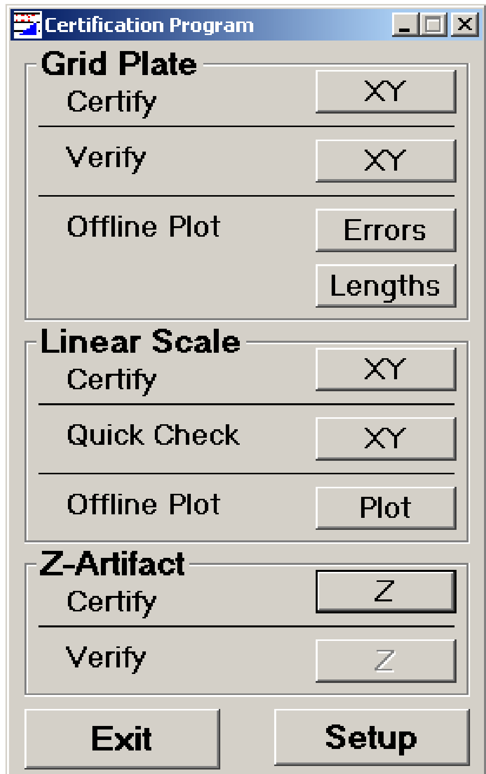
15. [XY Verification ONLY] Click the **XY Cert Plate Info** tab and enter the following information:

- P.O. number of the plate — all digits must match the `XYNOM.CRT` file
- serial number of the plate — leading zeros are ignored
- number of unreachable lines (if any) on each side of the plate

16. [Z Verification ONLY] Click the **Z Artifact Info** tab. Then enter the Artifact set # (must match the `ZNOM.CRT` file) and select the **Gage Blocks** radio button or the **Step Gage** radio, depending on which method you will be using to verify the Z-axis. Then enter the correct offset information.

17. After all the parameters have been set and the customer information has been updated, click **Done**.

The following appears:



You are now ready to perform an XY Verification (see ***XY Verification*** on page 250) or a Z Verification (see ***Z Verification*** on page 254).

Caution: Do not close the Certification Program window. Doing so will require you to re-enter customer and temperature information.

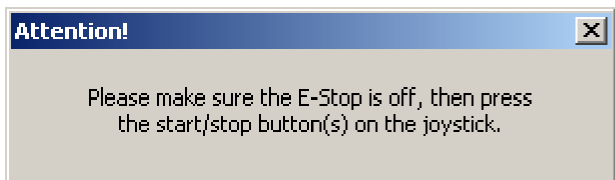
A.6.2 XY Verification

Caution: Data file `XYVER.DAT` is created automatically at the end of the XY Verification process. If you want to save the old file, rename it before running this process.

1. Perform the Verification Setup procedure on page 246.

2. Click the Verify **XY** button.

   The Cert & Verify program automatically launches the VMS software and the following appears:



Note: A window may appear excluding a number of lines from the top and right sides of the plate. This is normal, click **OK**.

3. Make sure the E-Stops are pulled out, and then press the **Stop/Start** button on the joystick.

4. Wait for the VMS software to launch and then click **Continue** in the Certification Program instruction window.

5. Move the Certification Program instruction window to the lower-right corner of the screen, so you can see prompts and messages that appear during the verification process.

6. Verify that the stages are clear to move, and then click **Continue** in the Certification Program instruction window to zero the stages.

7. Wait for the stages to stop moving and observe the Ready/Not-Zeroed status display switch to *Ready*. Then click **Continue** in the Certification Program instruction window.

Note: If you are directed to *select OK*, do not press Enter on the keyboard — doing so will be interpreted as a “cancel” instruction in the program. Instead, click **OK** with the mouse.

Caution: You may receive the following message:

The lens used by this program is not mounted. The wrong lens may be in use.

This error message is normal and is a precaution. Check and make sure you are using the correct lens. If the lens is correct, click **OK** and continue with this procedure. If the wrong lens is installed, abort the verification process and install and calibrate the correct lens before restarting.

Note: If a warning appears for lighting configuration, click **OK**.

Caution: As the program loads, a number of screens may appear and then disappear. This is normal; do not press any keys or mouse buttons while the program loads, unless prompted to do so.

8. Click in the VMS toolbar.

9. Adjust the coaxial light intensity so you can image and focus the 0/0 intersection at the center of the XY grid plate.

a. Use the joystick to drive the stages so the 0/0 intersection (see Figure A-5) appears in the Video window.

b. Click in the Video Window toolbar and center the Crosshair Finder over the 0/0 intersection. Then focus the intersection.

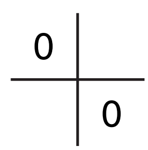


Figure A-5 0/0 intersection

c. Align the plate so it is parallel to the X travel, assuring full travel and good focus in both X and Y directions; adjust the plate height if needed. Full travel assumes that, during the entire Cert and Verify process, all outer intersections (except those excluded in the setup) used in `XYNOM.CRT` can be imaged.

d. After the plate has been aligned, re-position the Crosshair Finder over the 0/0 intersection.

e. Focus again.

Caution: Before clicking Set Home in the next step, be aware that the stages will return to this location when you click Go Home.

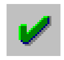
f. Click **Set Home** to establish the current XYZ position as the home position.

10. After all alignments are complete and the XY grid plate is secure, click **OK** in the Autofocus Finder window.

Caution: Before selecting Go Home in the next step, make sure it is safe for the stages to move.

11. The stages may have moved to a preset position in the program. Click **Go Home** to drive the stages to the home position you defined earlier.

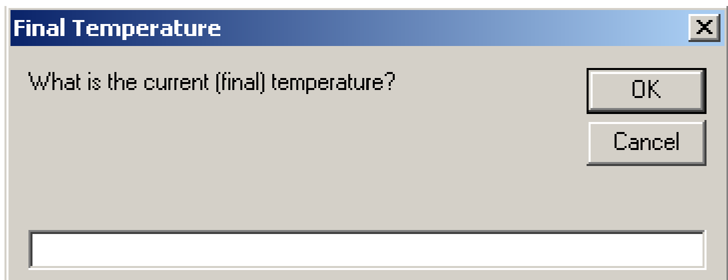
12. Double-click the left mouse button in the Video window.

13. Click  to store the position and begin the verification process.

Note: Light levels are adjusted automatically. If the system cannot converge on a light level, a prompt will appear for the user to select a coaxial light level manually. Record the number, and then enter the value at the prompt.

Note: A status bar that shows the progress of the Verification program appears in the instruction window.

When the verification process is complete, the system displays the following:



14. Enter the current room temperature and click **OK**.

A *PASS* or *FAIL* message appears in the Certification Program window.

15. Click **Make LUT** to improve the current lookup table.

16. Save (i.e., manually copy) the `XYVER.DAT` file from the current VMS directory onto removable media. This is a text file that can be viewed or printed at a later date from any standard PC.

17. Close the Verification window, and exit the Cert & Verify program.

18. Remove the XY grid plate from the worktable.

A.6.3 Z Verification

Caution: Data file `ZVER.DAT` is created automatically at the end of the Z Verification process. If you want to save the old file, rename it before running this process.

Note: Although, you can use a Z-axis step gage or a Z-axis gage block fixture and gage blocks to perform the Z-axis verification, we recommend using a step gage.

Note: Use the highest available magnification lens to perform the Z verification.

A.6.3.1 Z Verification with a Step Gage

1. Perform the Verification Setup procedure on page 246.

2. Click the Verify **Z** button.

   The Cert & Verify program automatically launches the VMS software and the following appears:

3. Make sure the E-Stops are pulled out, and then press the **Stop/Start** button on the joystick.

4. Wait for the VMS software to launch and then click **Continue** in the Certification Program instruction window.

5. Move the Certification Program window to the lower-right corner of the screen, so you can see prompts and messages that appear during the verification process.

6. Verify that the stages are clear to move and then click **Continue** in the Certification Program instruction window to zero the stages.

7. Wait for the stages to stop moving and observe the Ready/Not-Zeroed status display switch to *Ready*. Then click **Continue** in the Certification Program instruction window.

8. Temporarily mount the Z-axis step gage to the worktable as shown in Figure A-6. Make sure:

- the step gage steps ascend toward you when you are standing in front of the machine
- the step gage is placed toward the front of the worktable
- the step gage is visually square in the X and Y directions
- the step gage is secure on the worktable and will not move during the verification process

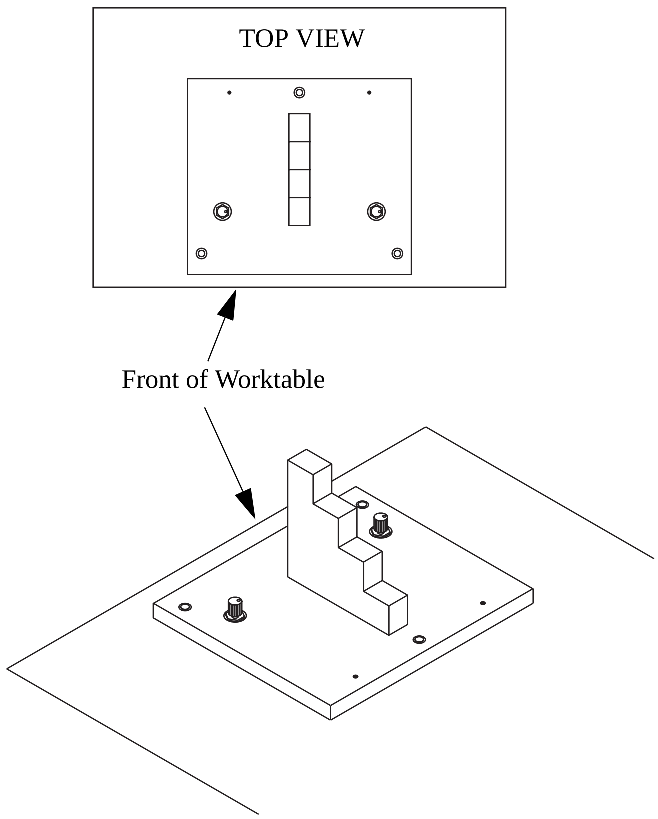


Figure A-6 Mounting the Step Gage on the Worktable

Note: If you are performing this procedure immediately after the Z Certification procedure and the step gage has not been moved, you can skip the next step because the step gage should still be level.

9. Level the step gage to within **±0.002 mm (0.00008")**.

a. Use the joystick to drive the stages so focus point ❶ (see Figure A-7) appears in the Video window.

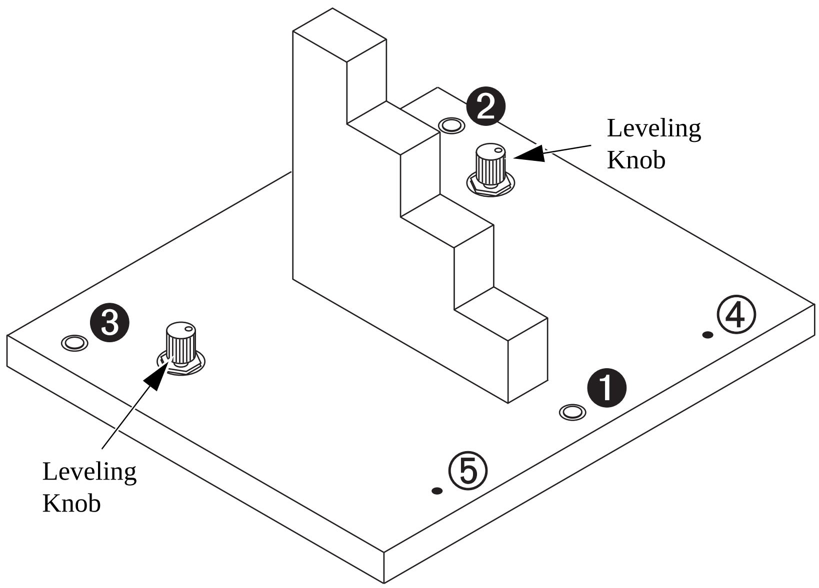
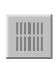
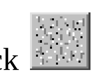


Figure A-7 Leveling the Step Gage

b. Click  in the Video Window toolbar, and then click  in the Autofocus Settings window to select the Textured Surface Focus tool.

c. Select the High Mag camera and perform an autofocus on focus point ❶.

d. Right-click in the DRO window and select **Zero DRO** in the context menu.

e. Drive the stages so focus point ❷ (see Figure A-7) appears in the Video window.

f. Perform an autofocus on focus point ❷.

The Z value in the DRO window should be zero or very close to zero.

- If the Z value for focus point ❷ is within ±0.002 mm (0.00008") of the Z value for focus point ❶, no adjustment is required; go to Step 9h.
- If the Z value is not within ±0.002 mm (0.00008"), use the leveling knob adjacent to focus point ❷ to level the step gage; continue with the next step.

g. Repeat Steps 9a through 9f.

h. Drive the stages so focus point ❸ (see Figure A-7) appears in the Video window

i. Perform an autofocus on focus point ❸. The Z value in the DRO window should be zero or very close to zero.

- If the Z value for focus point ❸ is within ±0.002 mm (0.00008") of the Z value for focus point ❷, no adjustment is required; continue with Step 10.
- If the Z value is not within ±0.002 mm (0.00008"), use the leveling knob adjacent to focus point ❸ to level the step gage; continue with the next step.

j. Repeat Steps 9a through 9i as many times as necessary to level the step gage to within ±0.002 mm (0.00008").

10. Set the Joystick Mode to **Slow**.

Note: If you are prompted to *select OK*, do not press Enter on the keyboard — doing so will be interpreted as a "cancel" instruction by the program. Instead, click **OK** with the mouse.

Caution: You may receive the following message:

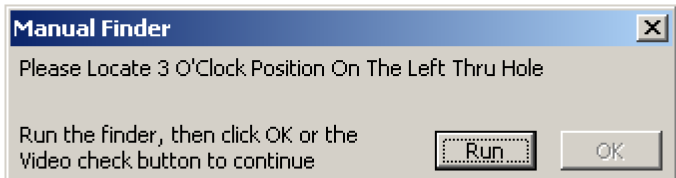
The lens used by this program is not mounted. The wrong lens may be in use.

This error message is normal and is a precaution. Check and make sure you are using the correct lens. If the lens is correct, click **OK** and continue with this procedure. If the wrong lens is installed, abort the verification process and install and calibrate the correct lens before restarting.

Caution: As the program loads, a number of screens may appear and then disappear. This is normal. Do not press any keys or mouse buttons while the program loads, unless prompted to do so.

11. Click in the VMS toolbar.

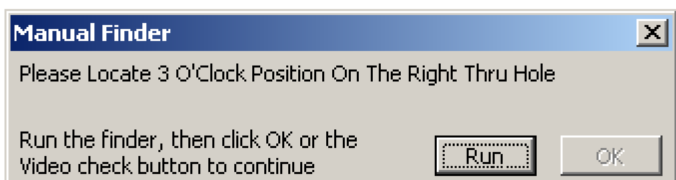
The following appears:



12. Drive the stages so the left through hole (④ in Figure A-7) appear in the Video window. Then position the Crosshair Finder on the right edge of the hole (3 o'clock position).

13. Click **Run** in the displayed prompt to run the finder, and then click **OK**.

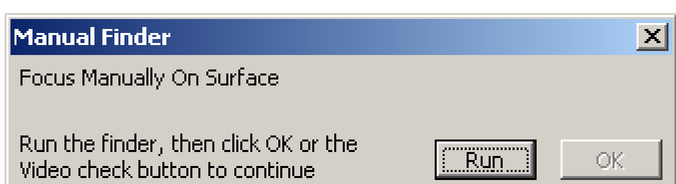
The following appears:



14. Drive the stages so the right through hole (⑤ in Figure A-7) appears in the Video window. Then position the Crosshair Finder on the right edge of the hole (3 o'clock position).

15. Click **Run** in the displayed prompt to run the finder, and then click **OK**.

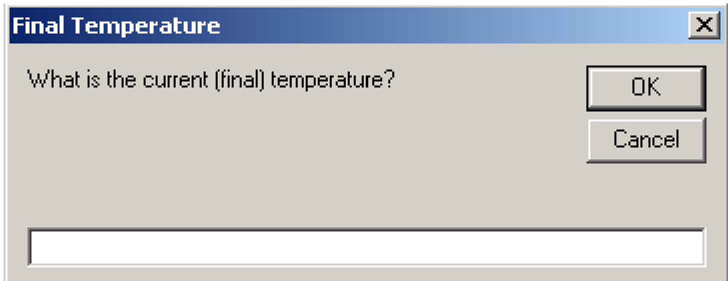
The system drives to the first step on the step gage and displays the following:



16. Manually focus on the top surface of the first step and click **Run** in the displayed prompt to run the finder.

17. Click **OK** to run the Z verification program.

When the verification process is complete, the following appears:



18. Enter the current room temperature and click **OK**.

A *PASS* or *FAIL* message appears in the Certification Program window.

19. Save (i.e., manually copy) the `ZVER.DAT` file from the current VMS directory onto removable media. This is a text file that can be viewed or printed at a later date from any standard PC.

20. Close the Verification window, and exit the Cert & Verify program.

21. Remove the Z-axis step gage from the worktable.

A.6.3.2 Z Verification with Gage Blocks

Note: The use of gage blocks requires you to place and remove blocks from the base block that is permanently mounted in a fixture.

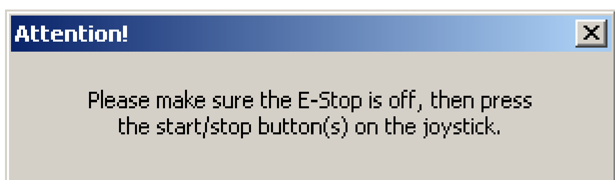
- If the Z verification is performed at 1-inch intervals, four blocks are used, one at a time, in the 1 through 4-inch range.
- If the Z verification is performed at 1/2-inch intervals, a 1/2-inch bock is used in combination with the four blocks for a 1/2-inch interval Z certification.
- For systems with 6 inches of travel in Z, the 1 and 2-inch blocks are wrung onto the 4-inch block.

The program automatically drives the Z-axis transport at the appropriate interval during the verification process.

1. Perform the Verification Setup procedure on page 246.

2. Click the Verify **Z** button.

   The Cert & Verify program automatically launches the VMS software and the following appears:



3. Make sure the E-Stops are pulled out, and then press the **Stop/Start** button on the joystick.

4. Wait for the VMS software to launch and then click **Continue** in the Certification Program instruction window.

5. Move the Verification Program window to the lower-right corner of the screen, so you can see prompts and messages that appear during the verification process.

6. Verify that the stages are clear to move, and then click **Continue** in the Certification Program instruction window to zero the stages.

7. Wait for the stages to stop moving and observe the Ready/Not-Zeroed status display switch to *Ready*. Then click **Continue** in the Certification Program instruction window.

8. Temporarily secure the Z-axis fixture to the worktable. The Z-axis fixture is mounted on center, in the X-axis direction.

Note: If you are prompted to *select OK*, do not press Enter on the keyboard — doing so will be interpreted as a “cancel” instruction by the program. Instead, click **OK** with the mouse.

Caution: You may receive the following message:

The lens used by this program is not mounted. The wrong lens may be in use.

This error message is normal and is a precaution. Check and make sure you are using the correct lens. If the lens is correct, click **OK** and continue with this procedure. If the wrong lens is installed, abort the verification process and install and calibrate the correct lens before restarting.

Caution: As the program loads, a number of screens may appear and then disappear. This is normal. Do not press any keys or mouse buttons while the program loads, unless prompted to do so.

9. Click in the VMS toolbar.

10. Set the Joystick Mode to **Slow**.

11. Find and focus the upper-right corner of the gage block that is permanently mounted on the fixture (see Figure A-8). You may have to adjust the coaxial light level.

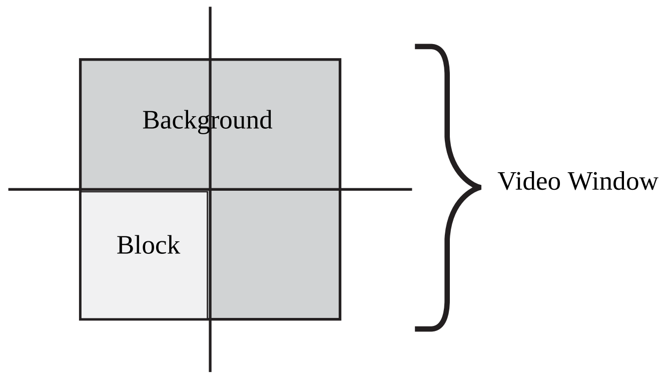
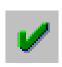


Figure A-8 Crosshair Location, Z-Axis Gage Block

12. Run the Crosshair Finder by double-clicking in the Video window. **Do not click the finder.**

13. Click  to store the position and begin the verification process.

Note: Light levels are adjusted automatically. If the system cannot converge on a light level, a prompt will appear for you to select a coaxial light level manually. Record the number, and then enter the value at the prompt.

- The system performs an autofocus on the base gage block that is permanently mounted on the fixture.
- The Z-axis stage moves up to the next step size in the verification series.

14. Observe the User Input window, and carefully follow the instructions; for example, place a 25.4 mm (1-inch) tall block on the base.

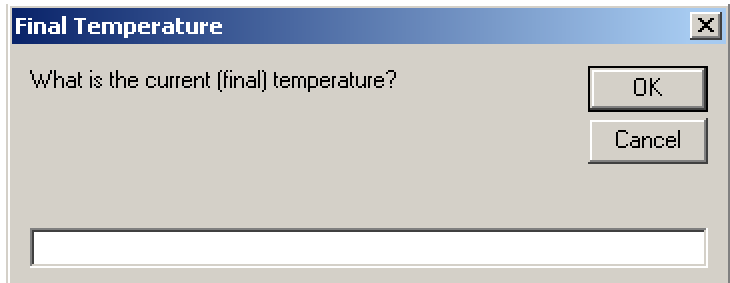
15. Wring in the next gage block; see ***Wringing Gage Blocks*** on page 224.

16. Click **OK**.

17. Observe the Z measurements with Ronchi grid in the User Input window.

18. Repeat Steps 14 through 17 until the verification process is complete.

When the verification process is complete, the following appears:



19. Enter the current room temperature and click **OK**.

A *PASS* or *FAIL* message appears in the Certification Program window.

20. Save (i.e., manually copy) the ZVER.DAT file from the current VMS directory onto removable media. This is a text file that can be viewed or printed at a later date from any standard PC.

21. Close the Verification window, and exit the Cert & Verify program.

22. Remove all stacked gage blocks from the Z-axis fixture and remove the fixture from the worktable.

This page has been left intentionally blank.

TTL Laser Calibration

Appendix B

B.1 What This Appendix Contains

This appendix covers the following:

- TTL Laser Alignment
- TTL Laser Calibration
- TTL Laser Verification

Tools Required	Part No.
2.5X, 5X or 10X magnification lens	638940, 638941, 638942
Set of Metric Allen wrenches	N/A
Gage block	N/A
VMS metrology software	N/A
LOCTITE 242	N/A
`TTL LASER QUALIFICATION.VOY`	N/A

Note: In order to use the TTL laser, the 2.5X, 5X, or 10X magnification lens must be installed. You cannot use the laser with any other lens.

B.2 TTL Laser Alignment

1. Launch the VMS software.
2. Click **Zero Stage** in the Stage and Lights window to zero the stages.
3. Install the lens (i.e., the 2.5X, 5X, or 10X lens) you want to use with the laser.
4. Select **Setup / Lens Calibration** in the VMS main menu to display the Lens Calibrations window (see Figure B-1).

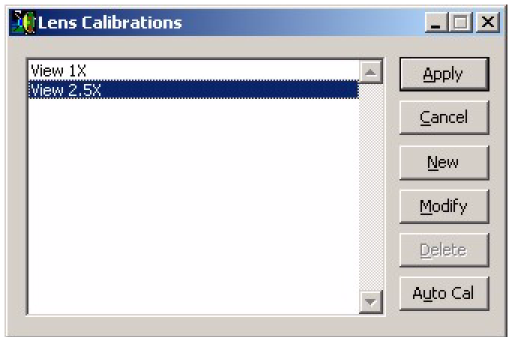


Figure B-1 Lens Calibrations Window

5. From the list, select the currently installed magnification lens and click **Apply**.
6. Click **Close** to close the window.

Note: If the lens you want to use is not listed in the Lens Calibrations window, you will have to calibrate the lens before continuing (see *Lens Calibration* on page 153).

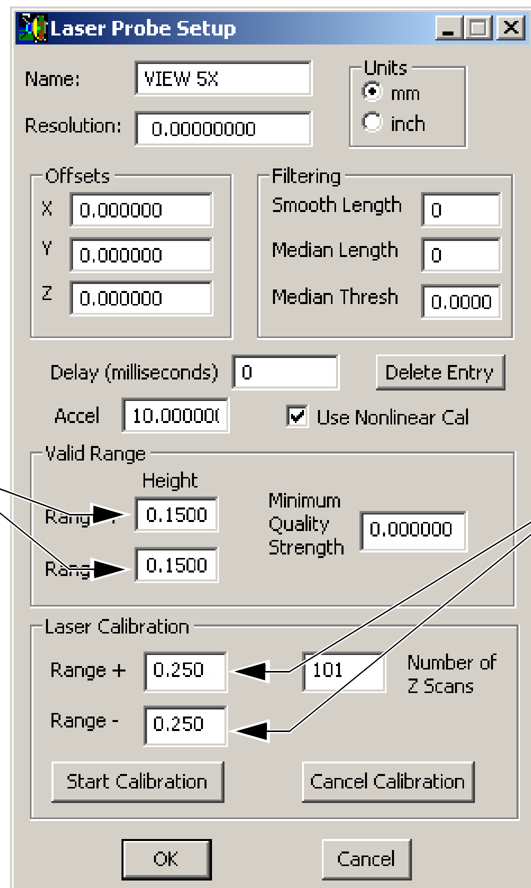
7. Place and secure a gage block on the worktable. Then optically focus on the surface of the block.

8. Select **Setup / Laser Probes** => **New Probe** in the VMS main menu to display the Laser Probe Calibration window (see Figure B-2).

Note: If the currently installed lens (for example, “View 5X”) is already listed in the Setup / Laser Probes menu, select it and click **Delete Entry** in the Laser Probe Calibration window to delete the laser probe calibration data for the lens. Then perform Step 8.

These values vary depending on which magnification lens is being used.

- Type 0.500 in each field if the 2.5X lens is installed
- Type 0.150 in each field if the 5X lens is installed (shown here)
- Type 0.050 in each field if the 10X lens is installed

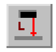


These values vary depending on which magnification lens is being used.

- Type 0.600 in each field if the 2.5X lens is installed
- Type 0.250 in each field if the 5X lens is installed (shown here)
- Type 0.150 in each field if the 10X lens is installed

Figure B-2 Laser Probe Calibration Window

9. Type a descriptive name for the currently installed lens (for example, View 5X) in the **Name** field and edit the other fields to match those shown in Figure B-2. When finished, click **OK**.

10. Click  in the Video Window toolbar to display the Laser Scan window.

If the Basic Laser Scan Parameters window (see Figure B-3) is displayed, click **Advanced** to display the Advanced Laser Scan Parameters window (see Figure B-4).

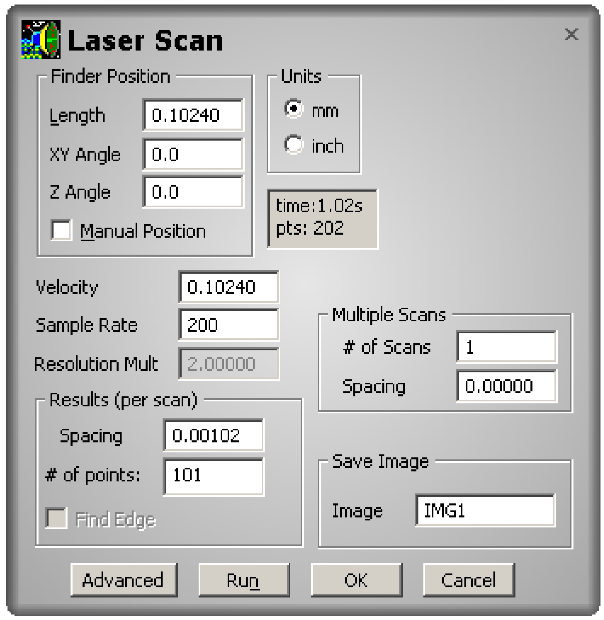


Figure B-3 Laser Scan Window (Basic)

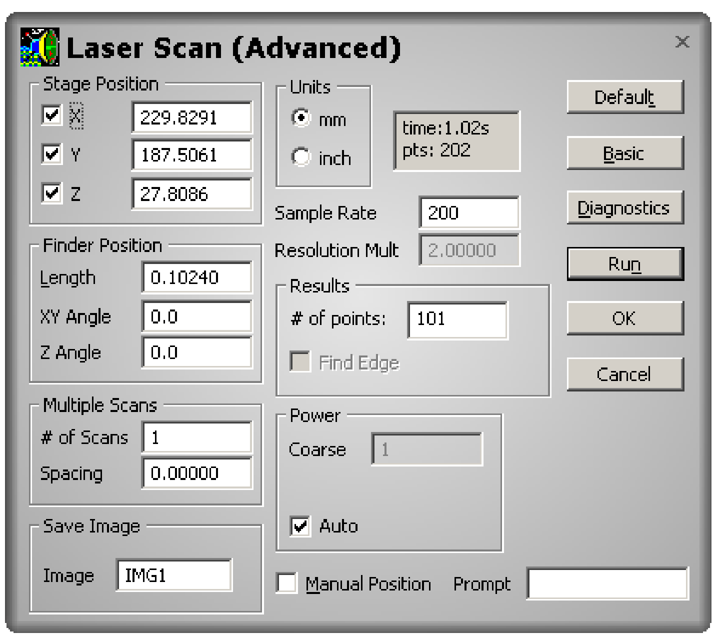


Figure B-4 Laser Scan Window (Advanced)

11. Click **Diagnostics** to display the Laser Input (laser diagnostics) window (see Figure B-5).

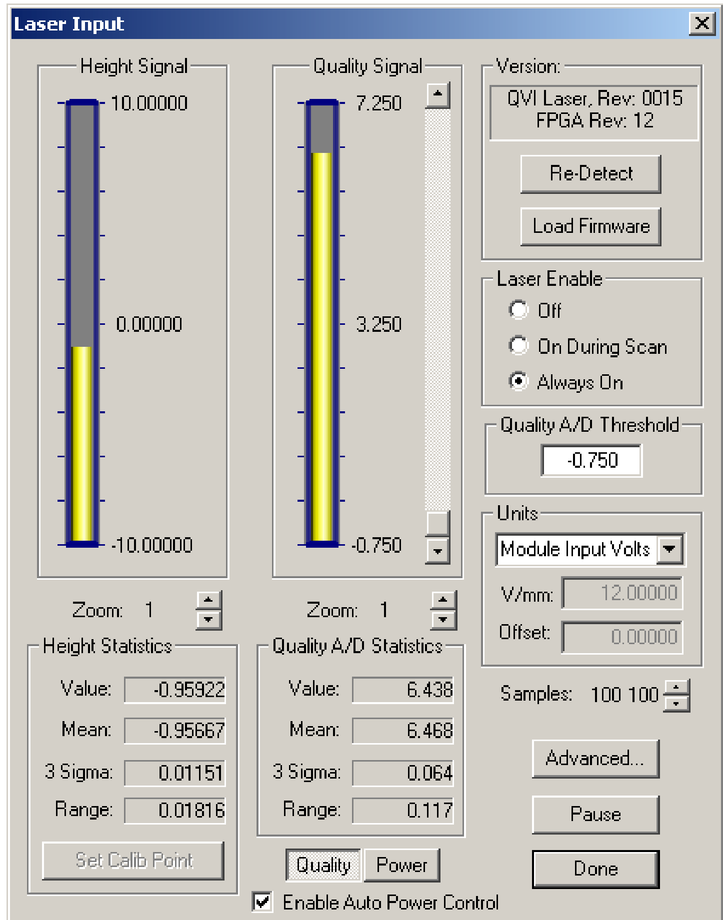


Figure B-5 Laser Input Window (Laser Diagnostics)

12. Move the Laser Input window so you can see the Video window. You should now see the laser spot on the surface of the gage block.

13. Adjust the coaxial light intensity to 0% and observe the position of the laser spot.

- If the laser spot is centered on the Laser Finder graphic (see Figure B-6), go to Step 17.
- If the laser spot is not centered, continue with the next step to make the required adjustment.

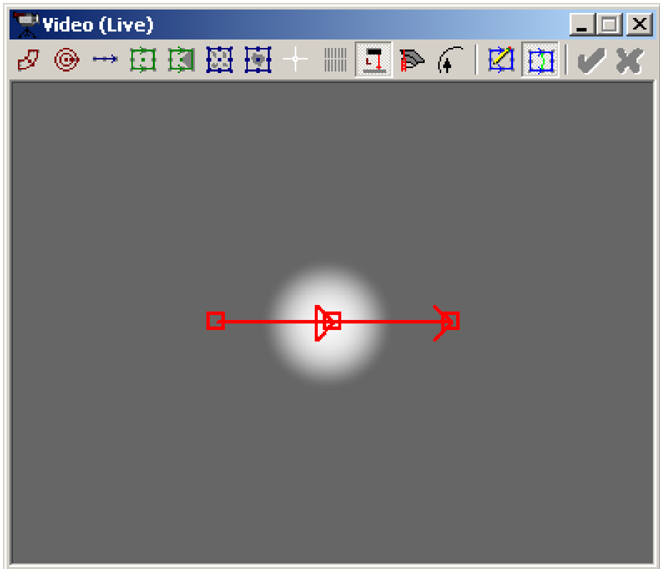


Figure B-6 Laser Spot Centered on the Laser Finder Graphic

14. Use a 2.5 mm Allen wrench to loosen the laser pull screws (see Figure B-7) one full turn.

15. Use a 2 mm Allen wrench and the laser push screws to center the laser spot on the Laser Finder graphic, as shown in Figure B-6.

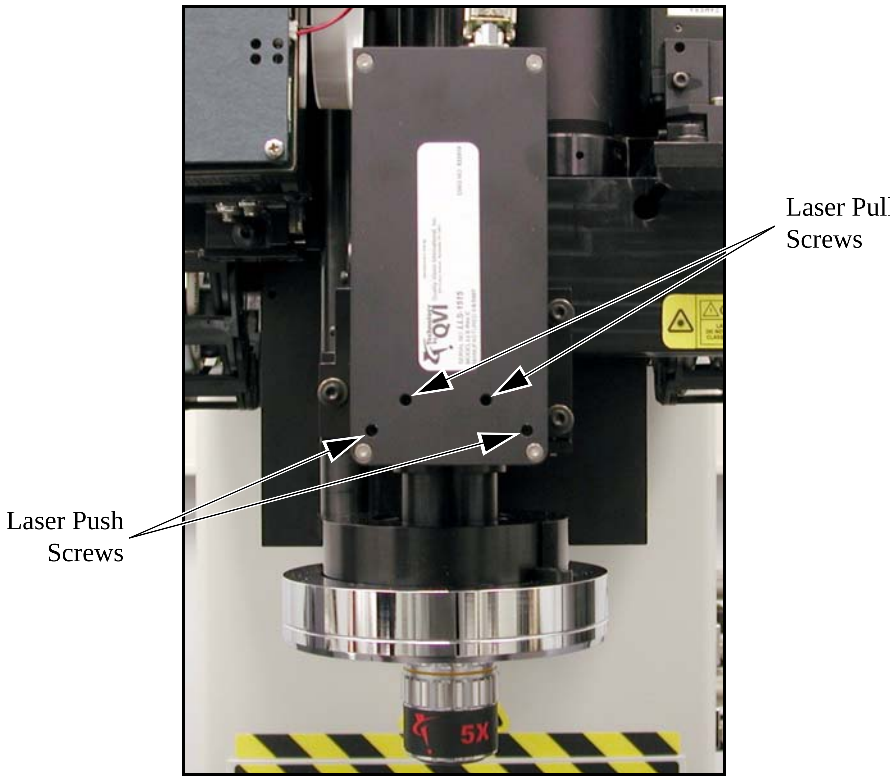
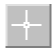


Figure B-7 Location of the Laser Push/Pull Screws

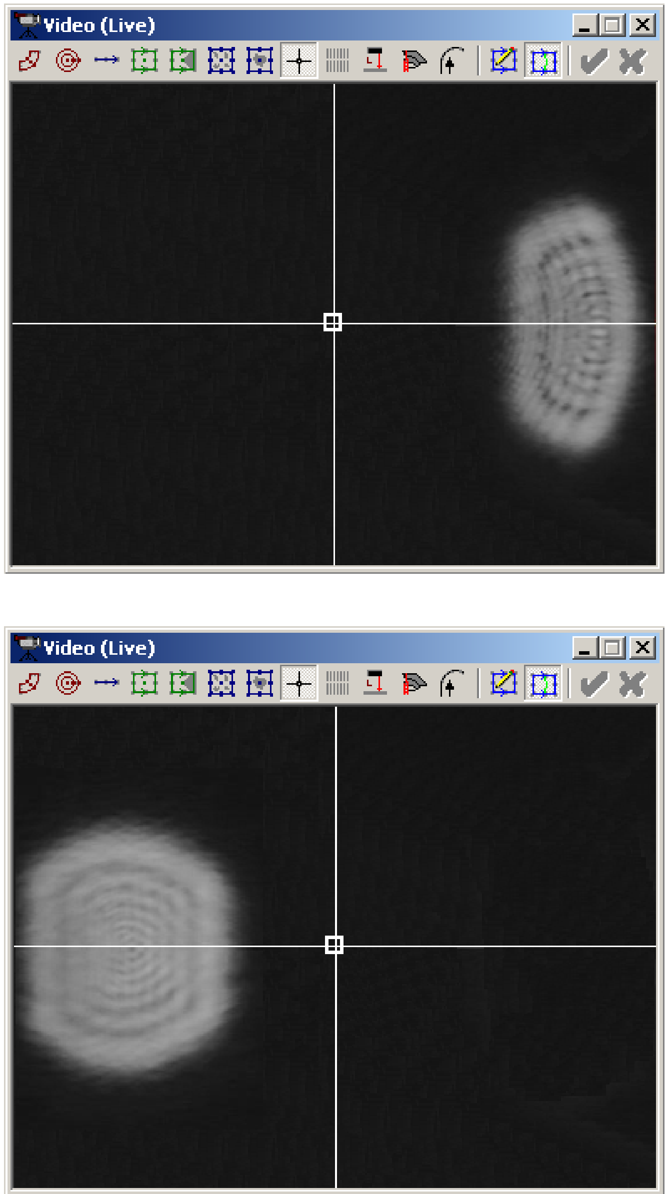
16. Make sure the laser push/pull screws are snug.

Note: The pull screws are spring-loaded. After tightening them, turn each screw CCW 1/4 turn from tight and apply LOCTITE 242 to prevent the screws from loosening.

---

17. Click  in the Video Window toolbar.

18. Use the joystick to raise and lower the Z-axis transport while observing the laser spot displayed in the Video window. If the laser spot remains centered on the horizontal centerline (no visible drift) at high and low magnification, go to Step 22. Otherwise, continue with the next step to make the required adjustment.



Z UP

Z DOWN

Figure B-8 Checking Laser Drift

Caution: Do not perform the following adjustment steps until you have determined that an adjustment is necessary.

Warning: To avoid exposure to Class 3R laser radiation, do not fully loosen or remove the laser alignment plate mounting screws (see Figure B-9), which secure the laser assembly to the optical assembly. If you inadvertently remove the laser assembly, avoid direct eye exposure to the beam.

19. Use a 2.5 mm Allen wrench to **loosen** the three laser alignment plate mounting screws (see Figure B-9). Loosen the mounting screws just enough to be able to adjust the vertical adjustment screws.

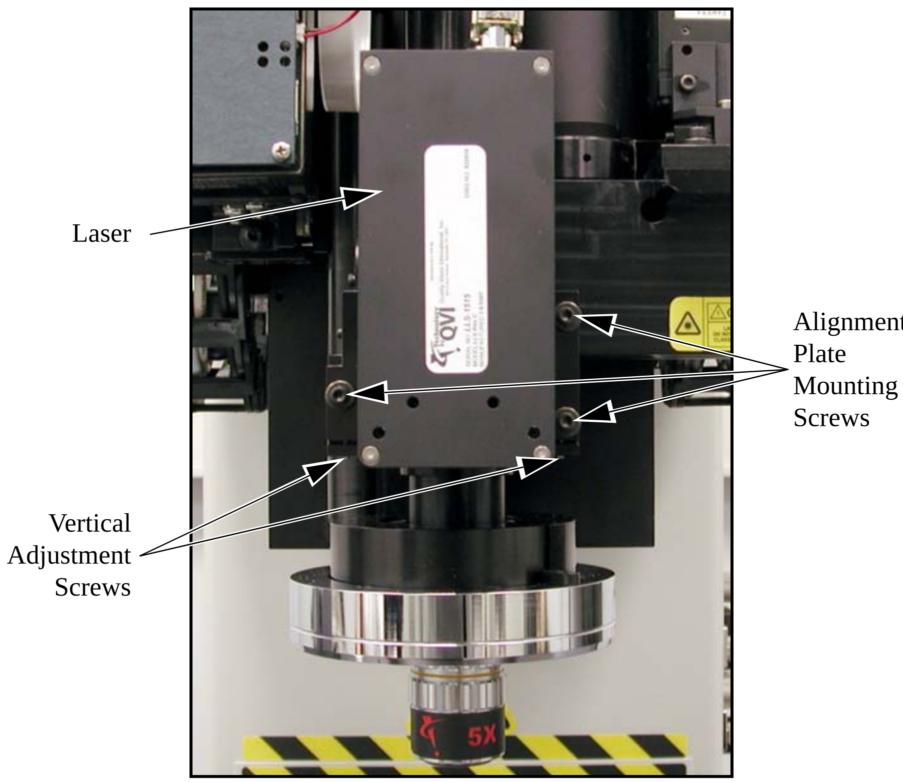
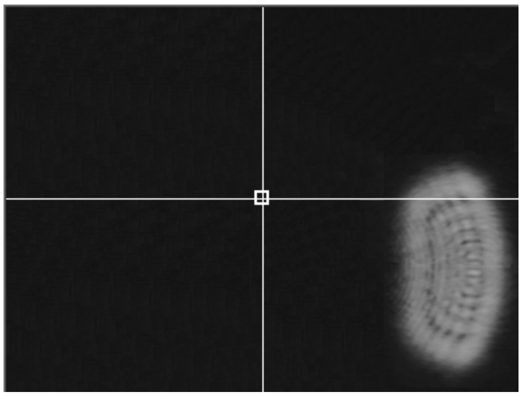


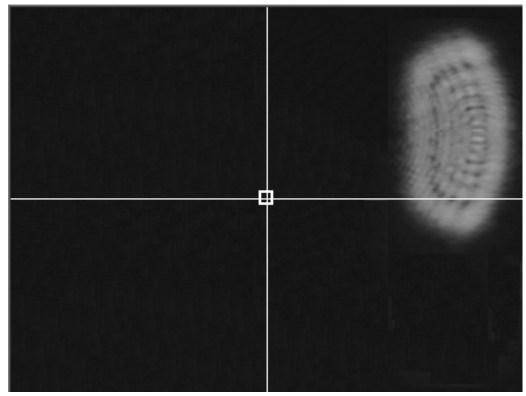
Figure B-9 Location of the Vertical Adjustment Screws

20. Use the joystick to raise the Z-axis transport so the laser spot appears on the right side of the Video window.

- If the laser spot is below the horizontal crosshair, turn the vertical set screws (see Figure B-9) CW to move the laser spot up.
- If the laser spot is above the horizontal crosshair, turn the vertical set screws CCW to move the laser spot down.



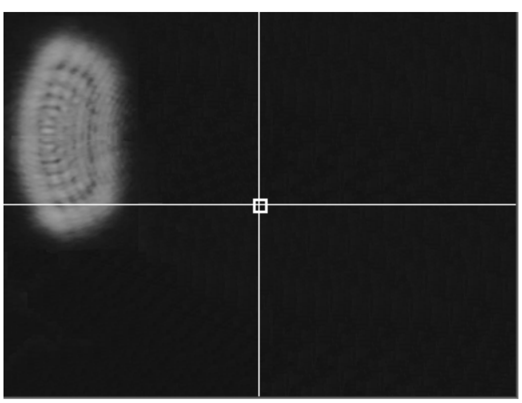
Turn vertical adjustment screws
CW to move laser spot up



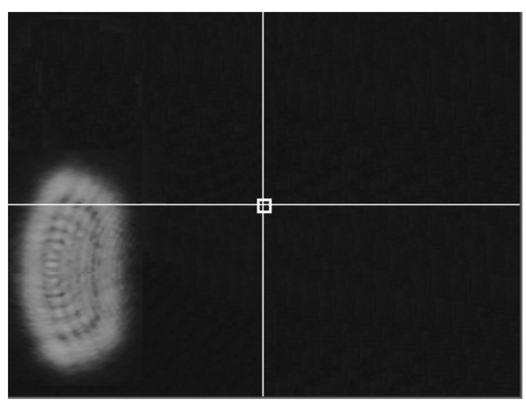
Turn vertical adjustment screws
CCW to move laser spot down

21. Use the joystick to lower the Z-axis transport so the laser spot appears on the left side of the Video window.

- If the laser spot is above the horizontal crosshair, turn the vertical set screws (see Figure B-9) CW to move the laser spot down.
- If the laser spot is below the horizontal crosshair, turn the vertical set screws CCW to move the laser spot up.



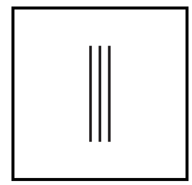
Turn vertical adjustment screws
CW to move laser spot down



Turn vertical adjustment screws
CCW to move laser spot up

22. Tighten the three laser alignment plate mounting screws.

23. Use the following reference target to check the laser to optics offset. Photocopy the target and secure the copy to the stage glass.



The reference lines are 1.25 mm apart from one another

Figure B-10 Laser to Optics Offset Reference Target

24. Select the Low Mag camera. Then increase the intensity of the coaxial light and focus the reference lines in the Video window.

25. Align the center reference line to the Crosshair Finder graphic.

26. Right-click in the DRO window and select **Zero DRO** from the context menu.

27. Without moving the paper or worktable, remove the magnification lens and set it aside.

28. Use the joystick to drive the X-axis stage so the X-axis readout displays **+3.75 mm**.

- If the laser spot is centered on the reference lines on the paper, go to Step 30.
- If the laser sot is not centered, continue with the next step to make the required adjustment.

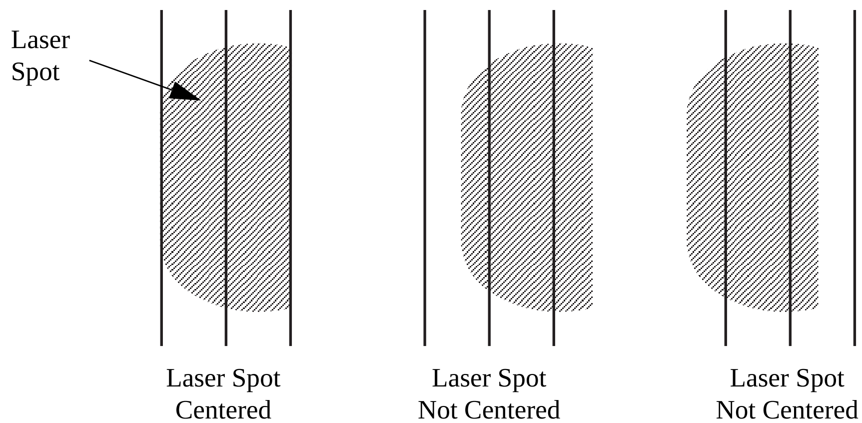


Figure B-11 Checking the Laser to Optics Offset

Caution: Do not perform the following adjustment steps until you have determined that an adjustment is necessary.

Warning: To avoid exposure to Class 3R laser radiation, do not fully loosen or remove the laser alignment plate mounting screws (see Figure B-9), which secure the laser assembly to the optical assembly. If you inadvertently remove the laser assembly, avoid direct eye exposure to the beam.

29. Use a 2.5 mm Allen wrench to **loosen** the three laser alignment plate mounting screws (see Figure B-12).

30. Use a 1.5 mm Allen wrench and the laser alignment plate push/pull screws to center the laser spot on the reference lines. When finished, tighten the three laser alignment plate mounting screws.

Note: Make sure the push/pull screws are not both tight at the same time, which may cause the alignment plate to rotate and move the laser spot away from the center of the Video window.

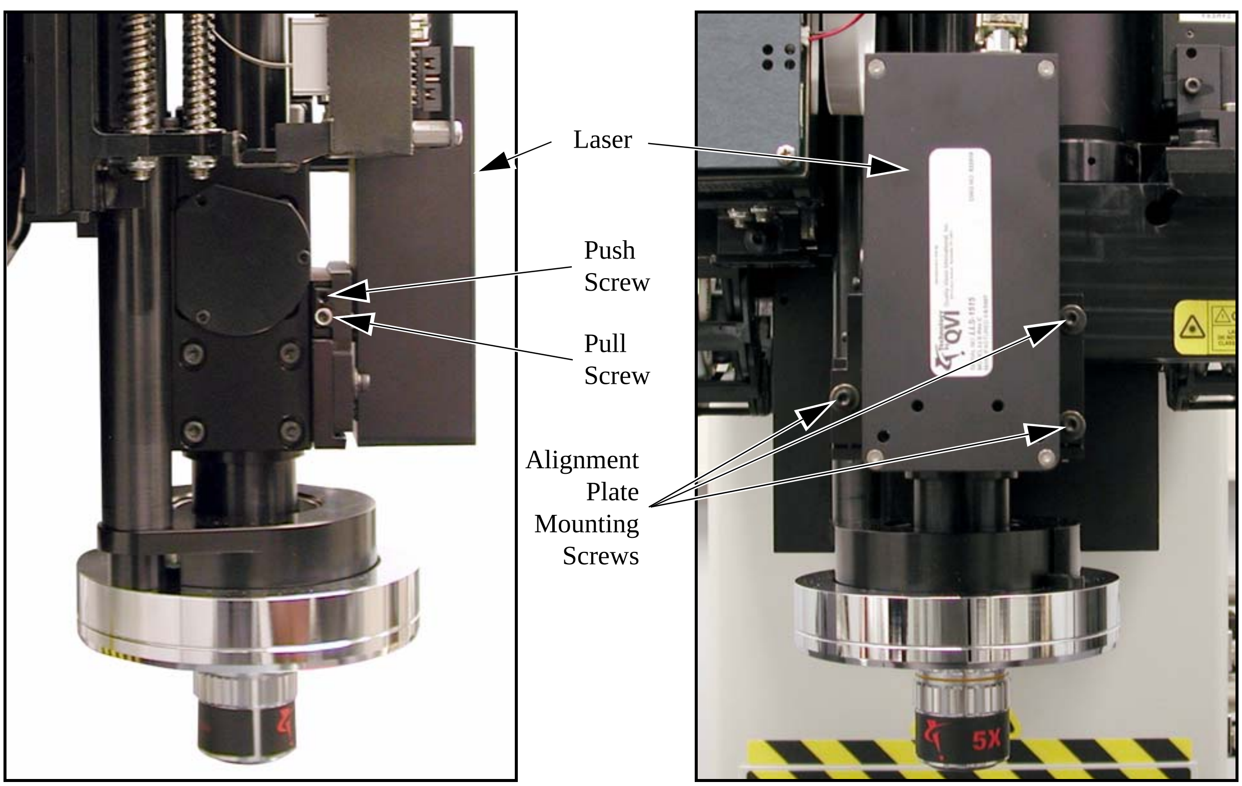


Figure B-12 Location of the Laser Alignment Plate Push/Pull Screws

31. Focus the optics on the surface of the gage block. If the system is equipped with the optional grid projector, perform a grid focus on the surface of the gage block.

32. Look at the **Height Signal** and **Quality Signal** scales in the Dual Signal Laser (laser diagnostics) window (see Figure B-5 on page 269). When the optics are focused on the surface of the gage block, the height signal should be 0 and the quality signal should be close to 10. If the height signal is 0, go to Step 33. Otherwise, continue with the next step to make the required adjustment.

33. Adjust the laser detector push/pull screws (see Figure B-13) until the height signal is 0. When finished, make sure the push/pull screws are snug.

Note: The height signal and quality signal are interrelated; the quality signal is at the optimal level when the height signal is 0.

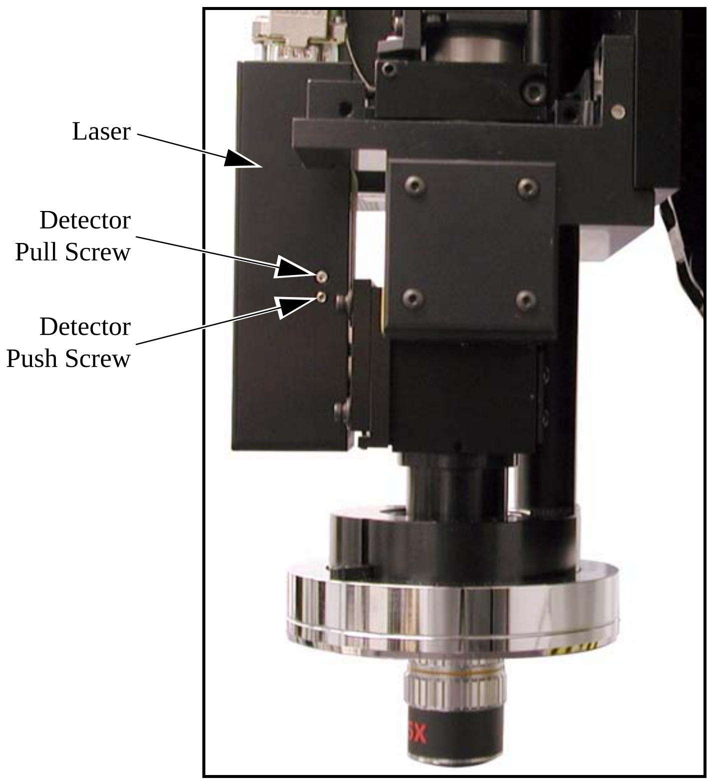


Figure B-13 Location of the Laser Detector Push/Pull Screws

34. Click **Done** to close the Dual Signal Laser (laser diagnostics) window and then click **Close** to close the Laser Finder Parameters window.

35. Perform the TTL Laser Calibration procedure on page 278.

B.3 TTL Laser Calibration

1. Launch the VMS software.

2. Zero the stages by clicking **Zero Stage** in the Stage and Lights window.

3. Install the lens you want to use with the laser and apply its calibration values from the Lens Calibrations window (see Figure B-1 on page 266).

Note: In order to use the TTL laser, the 2.5X, 5X, or 10X lens must be installed. You cannot use the laser with any other lens.

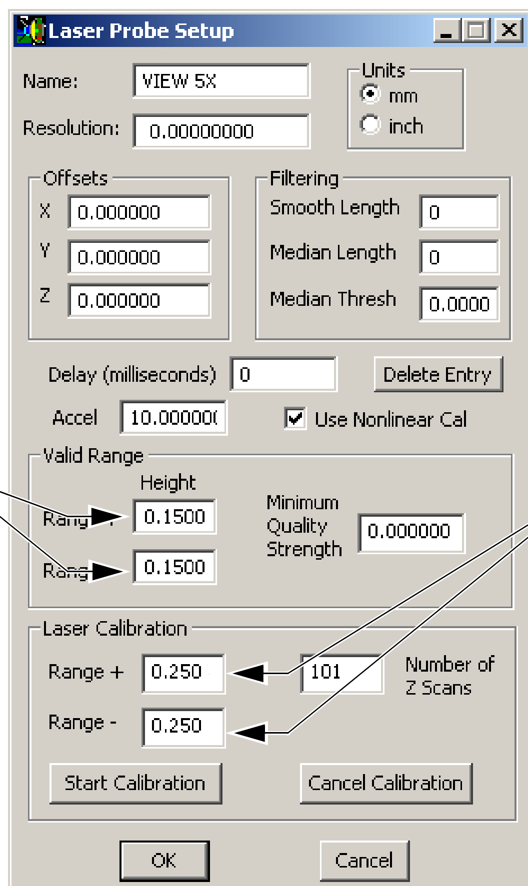
---

4. Place and secure a gage block on the worktable. Then optically focus on the surface of the block.

5. Select **Setup / Laser Probes** and the currently installed lens to display the Laser Probe Calibration window (see Figure B-14).

These values vary depending on which magnification lens is being used.

- Type 0.500 in each field if the 2.5X lens is installed
- Type 0.150 in each field if the 5X lens is installed (shown here)
- Type 0.050 in each field if the 10X lens is installed



These values vary depending on which magnification lens is being used.

- Type 0.600 in each field if the 2.5X lens is installed
- Type 0.250 in each field if the 5X lens is installed (shown here)
- Type 0.150 in each field if the 10X lens is installed

Figure B-14 Laser Probe Calibration Window

6. If necessary, edit the fields to match those shown in Figure B-14.

7. Click **Start Calibration** to begin the laser calibration.

If everything is set up properly, the program runs with no errors and iterates a calibrated resolution using the resolution value specified in the Laser Probe Calibration window for the installed lens.

The laser calibration program estimates the Z-axis zero using the latest resolution value, making measurements above and below the optical focal point and calculating a new resolution value from the data taken from three measurements. This process repeats until the deviation of the mean varies by less than a specified value.

8. When the calibration ends, click **OK** to save the results.

B.4 TTL Laser Verification

1. Launch the VMS software.

2. Click **Zero Stage** in the Stage and Lights window to zero the stages.

3. Install the magnification lens that was used during laser calibration.

4. Apply the lens calibration values from the Lens Calibrations window (see Figure B-1 on page 266).

Note: In order to use the TTL laser, the 2.5X, 5X, or 10X lens must be installed. You cannot use the laser with any other lens.

---

5. Place and secure a gage block on the worktable. Then optically focus on the surface of the block using coaxial illumination.

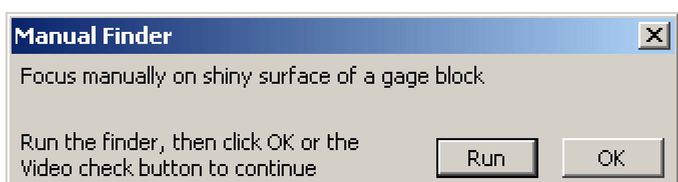
6. Click  in the VMS toolbar and open the `TTL LASER QUALIFICATION.VOY` part program.

7. Select the High Mag camera and manually focus on the surface of the gage block. Adjust the coaxial illumination if necessary.

8. Click  in the VMS toolbar and type the appropriate header information in the displayed User Input window.

9. Click **OK**.

The following appears:



10. Click **Run** to run the finder.

11. Click **OK** to run the program.

Results from the verification program appear in the Results window. If the program fails, perform the TTL Laser Alignment and TTL Laser Calibration procedures outlined in this appendix, and then re-run the verification program. Repeat until the program passes.

Accessing VMS Parameters

Chapter C

C.1 What This Appendix Contains

This appendix describes how to view the VMS parameters; it does not describe how to change parameters. Contact the Customer Support HelpDesk for information about changing parameters.

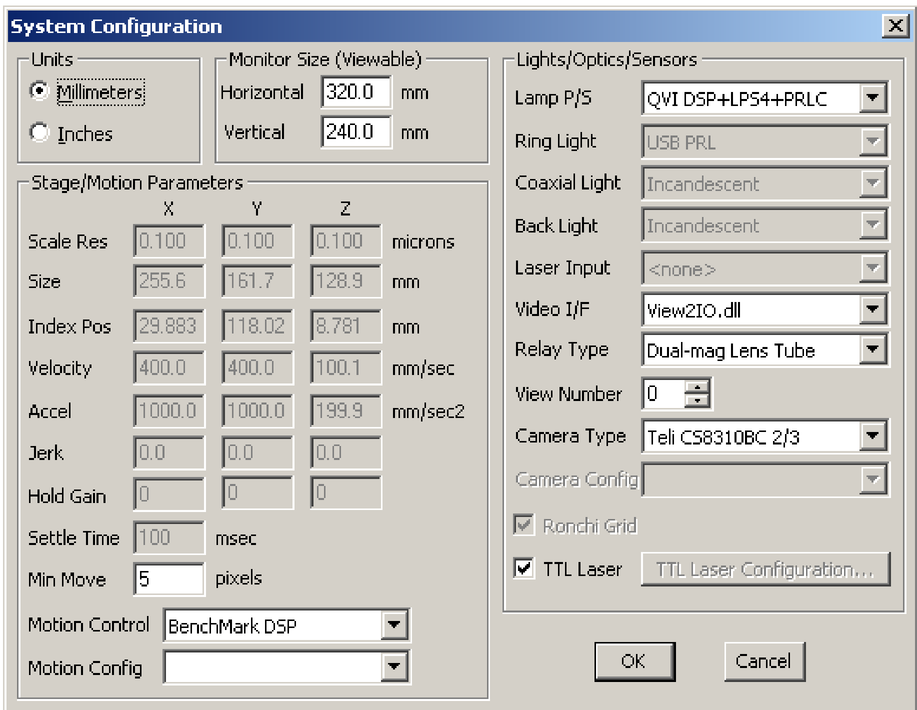
Caution: Do not change any parameters without consulting the Customer Support HelpDesk (see ***Where to Get Help*** on page 4).

C.2 Accessing Basic Parameters

1. Launch the VMS software.

2. Select **Setup / Options** => **System** in the VMS main menu.

   The system displays a window that shows the system configuration parameters. Typically, these parameters are locked for editing; contact the Customer Support HelpDesk (see ***Where to Get Help*** on page 4) for information about changing parameters.



3. Click **OK** to close the window.

C.3 Accessing Advanced Parameters

1. Using Windows Explorer, navigate to the following directory: `C:\PROGRAM FILES\VMS\EEPARAMS`

2. Create a backup of the `DSPPARAMS.TXT` file so you can refer back to it if necessary.

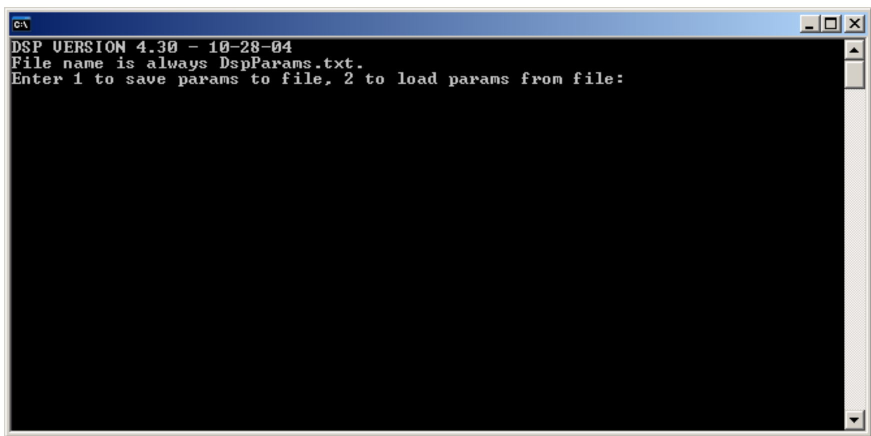
   a. Open the file `DSPPARAMS.TXT` in Microsoft® Notepad.

   b. Select **File** / **Save As** in the Notepad main menu.

   c. Type a unique name (for example, `DSPPARAMS_BACKUP.TXT`) in the **File name** box and click **Save**.

3. Double-click the `EEPARAMS.EXE` program.

   The following appears:



4. Type **1** and press **Enter** on the keyboard.

   The system saves the currently loaded parameters to the text file, `DSPPARAMS.TXT`. This file is located in the `C:\PROGRAM FILES\VMS\EEPARAMS` directory.

5. Open `DSPPARAMS.TXT` to view all of the current system parameters.

Caution: Do not make any changes to the `DSPPARAMS.TXT` file without consulting the Customer Support HelpDesk (see ***Where to Get Help*** on page 4).

Note: If you make any changes to the `DSPPARAMS.TXT` file, you must reload the parameters onto the DSP Multi Axis PCBA (as described on the next page) in order for the changes to take effect.

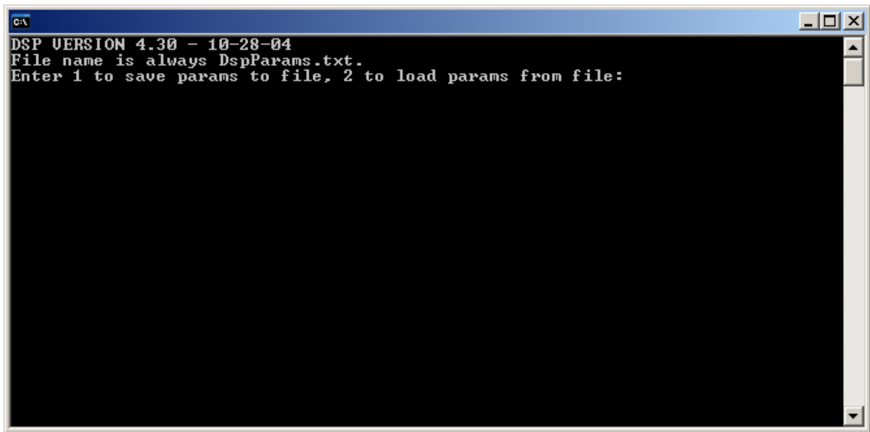
C.4 Loading Parameters

1. Use Windows Explorer to navigate to the following directory: `C:\PROGRAM FILES\VMS\EEPARAMS`

2. If necessary, overwrite the `DSPPARAMS.TXT` file already in the EEPARAMS directory with a new `DSPPARAMS.TXT` file.

3. Double-click the `EEPARAMS.EXE` program.

   The following appears:



4. Type **2** and press **Enter** on the keyboard.

   The system loads the parameters from the `DSPPARAMS.TXT` file onto the DSP Multi Axis PCBA.

Software Installation

Chapter D

D.1 What This Appendix Contains

This appendix covers the following:

- VMS Software Installation
- Elements Software Installation

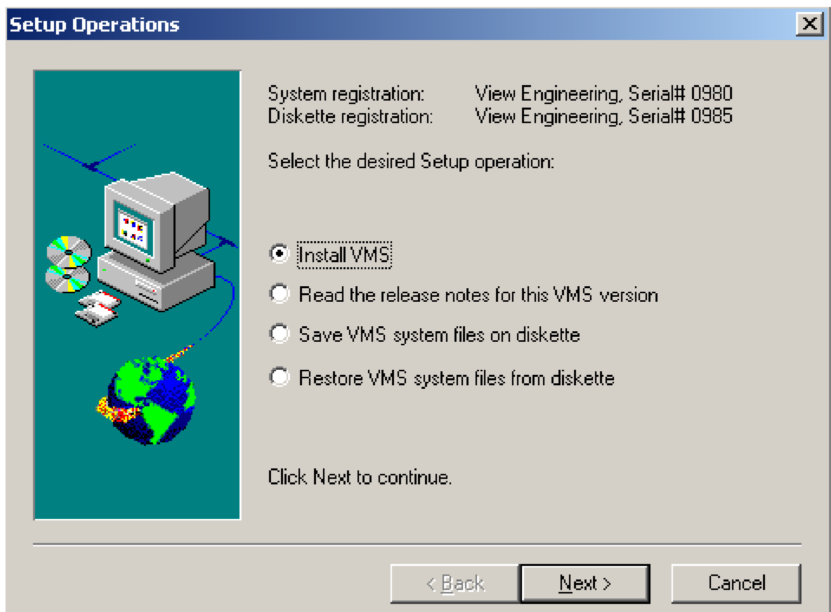
D.2 VMS Software Installation

Note: In addition to a VMS software CD, you will need an options disk for the system in order to install the VMS software.

Caution: We strongly recommend that you close all Windows programs before installing the VMS software.

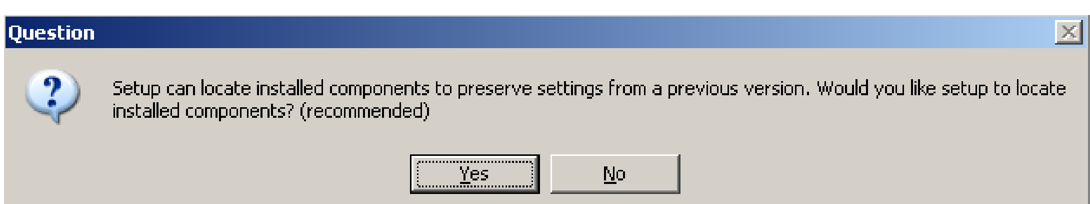
1. Insert the software CD into the CD-ROM drive and the options disk into the disk drive.

   The system reads the software CD and automatically displays the following.



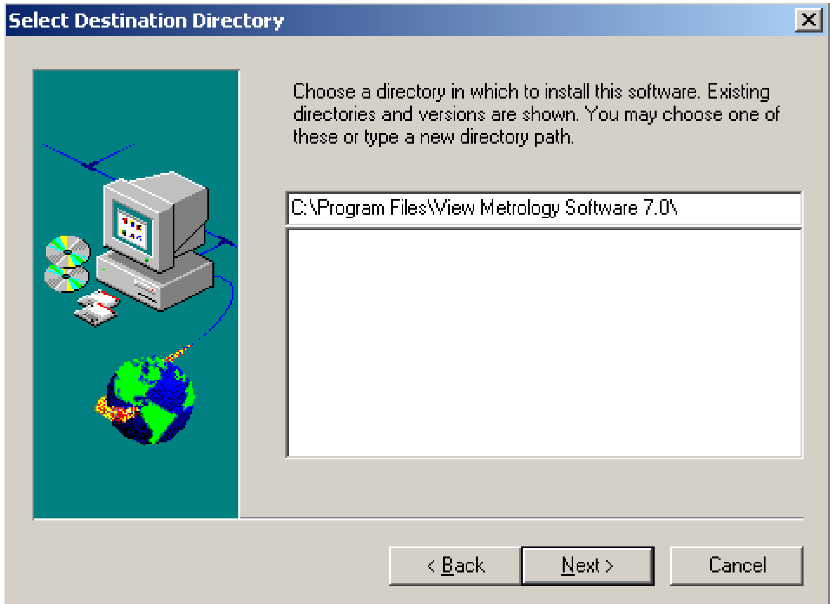
2. Click the **Install VMS** radio button and click **Next**.

   The following appears:



3. Click **Yes**.

The system searches for installed VMS software components and existing VMS software directories. When finished, the following appears:

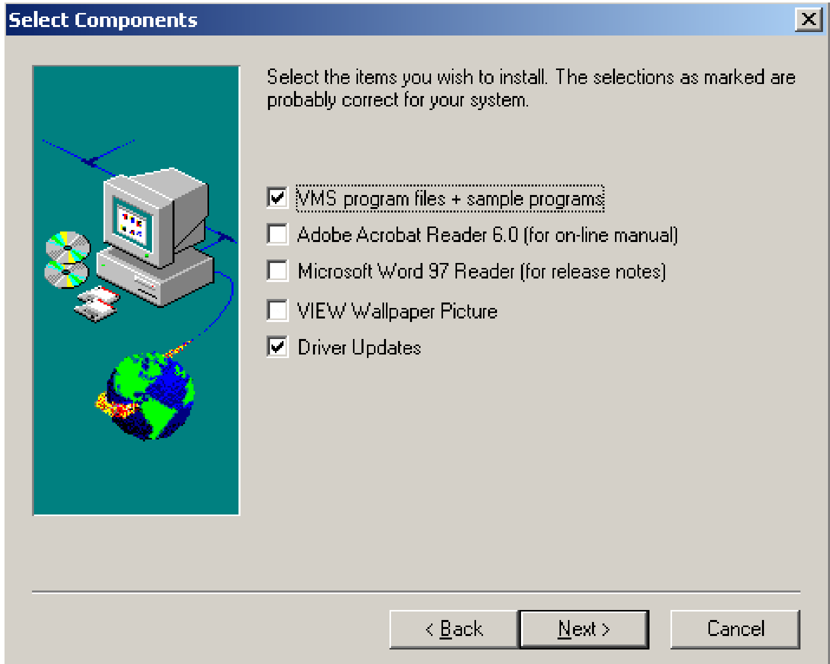


4. If you agree with the recommended directory shown in the Select Destination Directory dialog box, click **Next**. Otherwise, type a new directory path or select an existing directory before clicking Next.

Note: If an existing version of VMS was detected, it will appear in the Select Destination Directory dialog box.

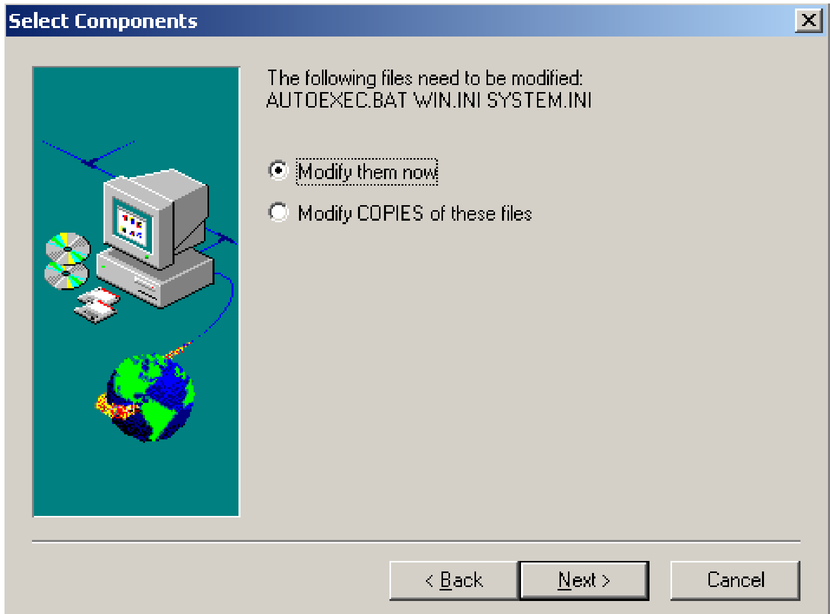
Note: If you choose to install the VMS software in an existing directory, the system displays a confirmation prompt. Click **Yes** to overwrite the existing files.

The following appears:

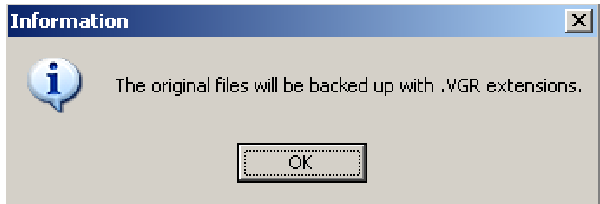


5. Select the **VMS program files + sample programs** and the **Driver Updates** checkboxes. If you want, select any of the other checkboxes to install the optional components. Then click **Next**.

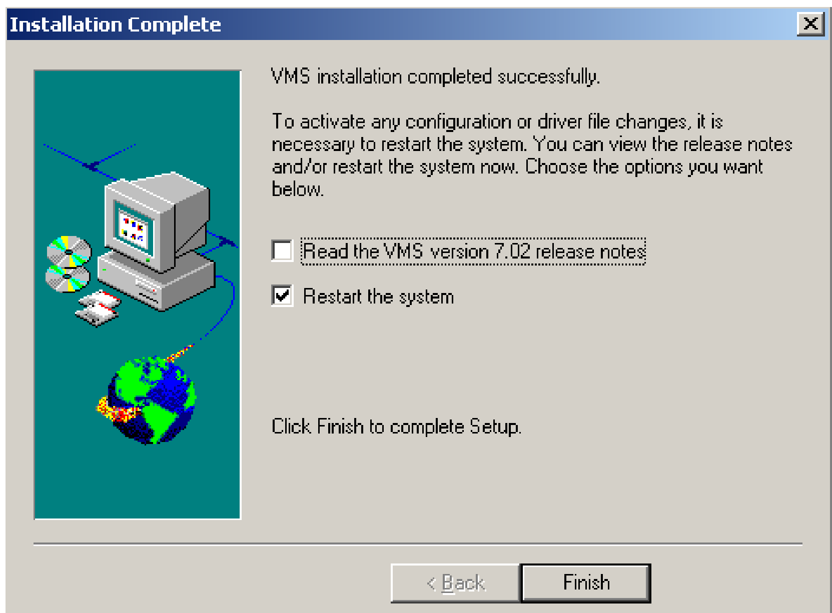
   The system starts copying files from the software CD and displays the following when finished:



6. Select the **Modify them now** checkbox and click **Next**. Then click **OK** in response to the following prompt:



The following appears:



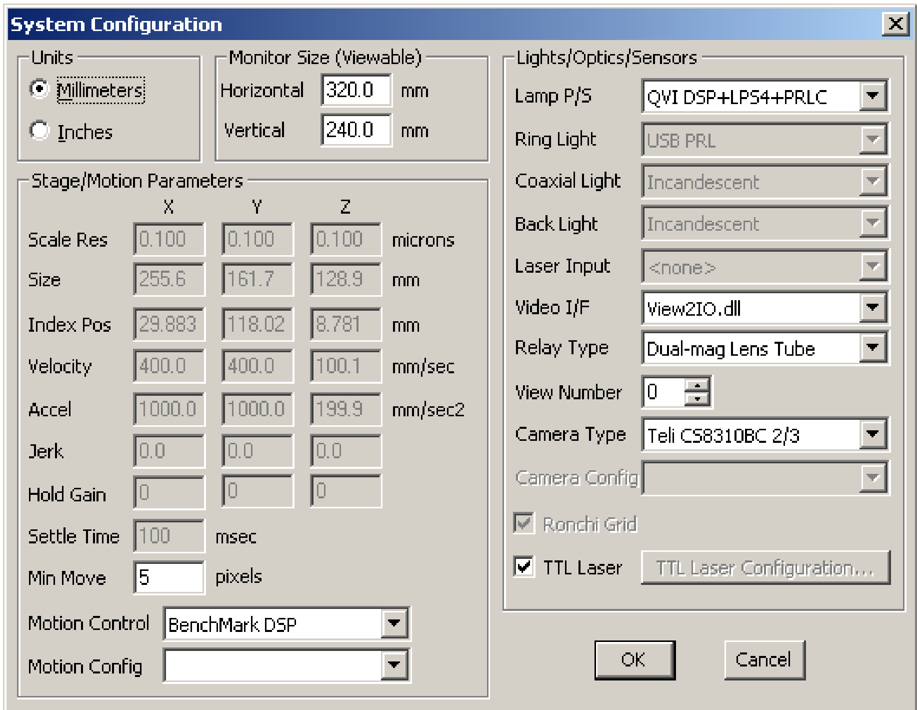
7. Select the **Restart the system** checkbox and click **Finish** to complete the setup program.

Note: If you want to view the VMS software release notes, select the **Read the VMS version 7.XX release notes** checkbox before clicking Finish.

---

8. Remove the software CD and options disk from their respective drives and store them in a secure place.

When you initially launch the VMS software, the following window appears. Click **OK** to close the window and access the VMS software.

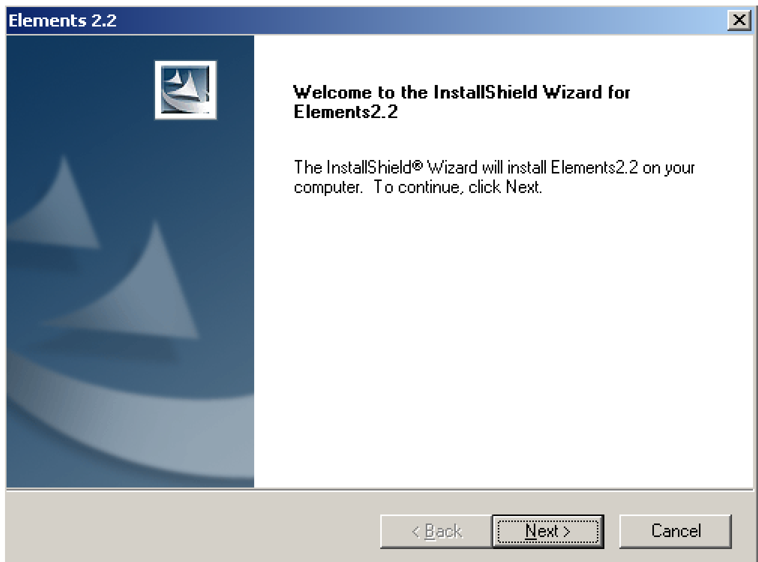


D.3 Elements Software Installation

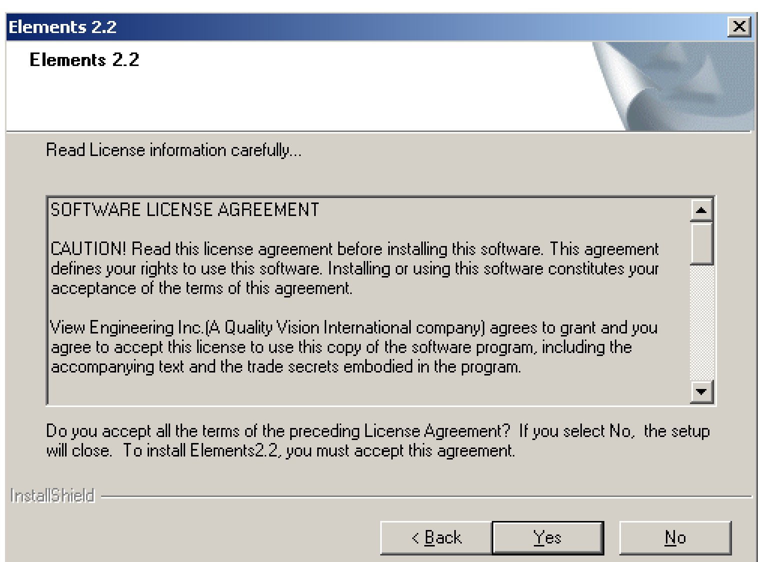
Caution: We strongly recommend that you close all Windows programs before installing the Elements software.

1. Insert the Elements software CD into the CD-ROM drive.

The system reads the software CD and automatically loads the InstallShield® Wizard.

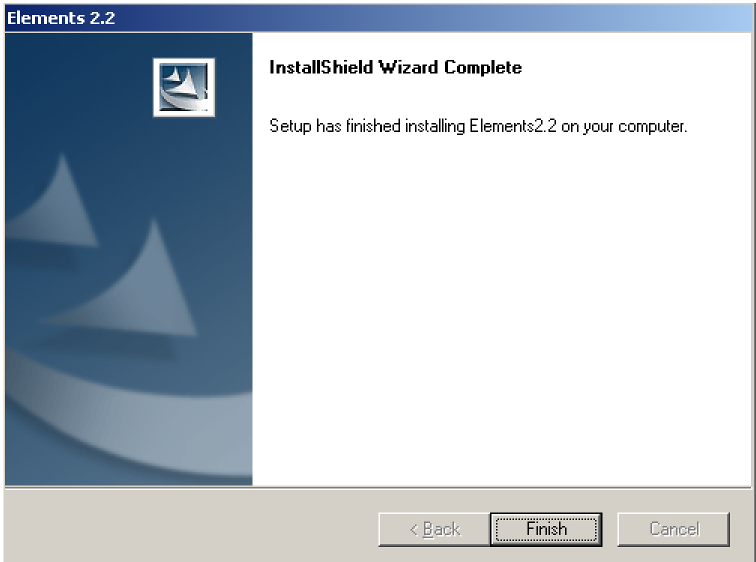


2. Click **Next** to display the following dialog box:



3. Read the license agreement and click **Yes** to install the software.

The system starts copying the necessary files and displays the following when finished:



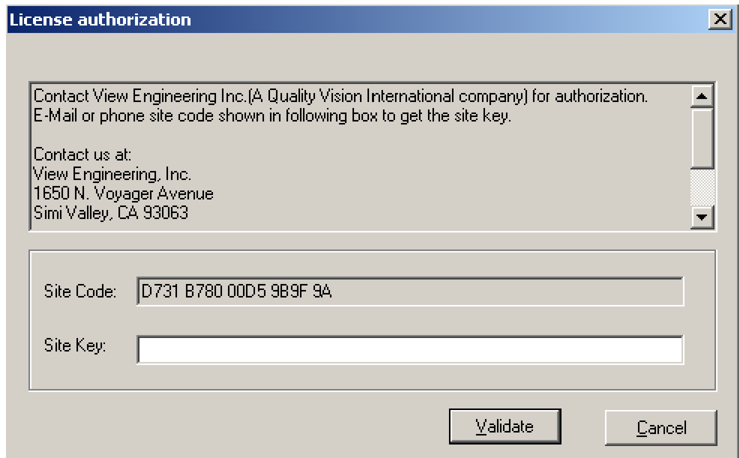
4. Click **Finish** to complete the installation.

Note: Although it is not required, we recommend that you restart the system before launching the Elements software.

When you initially launch the Elements software, the system displays a prompt to enter a valid site key in order to use the software.

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

2. Select **Help / License** in the Elements main menu to display the following:



3. Enter a valid site key in the Site Key box and click **Validate**.

Note: To obtain a site key, contact the Customer Support HelpDesk (see ***Where to Get Help*** on page 4).

This page has been left intentionally blank.

Index