



HDV500 Horizontal Digital Video System User Guide



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Table of Contents

1	About This Guide	5
1.1	Purpose	5
1.2	Scope	5
1.3	Audience	5
1.4	Prerequisites	5
1.5	Conventions	5
1.6	Disclaimer of Liabilities	6
1.7	Warranty	6
1.8	Copyright and Trademark Information	6
1.9	Related Product Information	7
2	Environmental and Regulatory Specifications	9
2.1	Operating Environment Specifications	9
2.2	Calibration Environment Specifications	9
2.3	Regulatory Compliance	9
2.3.1	EMC Standards	10
2.3.2	Safety Standards	10
2.3.3	Safety Considerations	10
3	The HDV500 System	13
3.1	Overview	13
3.2	Features and Capabilities	13
3.3	HDV500 System Components	14
3.3.1	Lens Options	15
3.3.2	MetLogix M3 Software	16
3.3.3	Operator Controls and Interfaces	17
3.3.4	Automatic and Manual System Operations	18
3.3.5	Rotary Stage Option	18
4	System Specifications	21
4.1	Performance	21
4.2	Mechanical	21
4.3	Illumination	22
4.4	Optical	22
4.5	Operator Controls	23
4.6	Electrical	23
4.7	Computer and Software	24
4.8	Rotary Stage Option	24
5	Installing and Setting Up the System	25
5.1	Planning the Placement of the System	25
5.2	Moving and Uncrating the Equipment	26
5.3	Removing the Stage Locks	27
5.4	Installing the Y-Axis Stage Cover	29
5.5	Mounting and Connecting the Video Monitor	30

6	System Operations	31
6.1	Using Automatic System Operations	31
6.2	Using the Manual System Operations	31
6.2.1	Using the Joystick to Control Operations	31
6.2.2	Using the Keyboard and Mouse Controls.....	33
6.2.3	Adjusting the Keyboard	34
6.3	Controlling Power to the System.....	34
6.3.1	Powering Up the System	35
6.3.2	Powering Down the System	36
6.4	Verifying Basic M3 Software Operations	36
6.5	Installing the Lockout Device	37
6.6	Removing and Replacing the Lenses	38
6.7	Using the Communication Ports.....	40
6.8	Verifying the Setup of the System.....	40
6.9	On-Site Installation, Calibration, and Training	41
6.9.1	Contacting Starrett Kinematic Technical Support	42
7	Understanding the Measurement Strategy	43
7.1	Telecentric Lens Magnification Strategy	43
7.2	Focus Strategy	43
7.2.1	Measurement Accuracy and Depth of Field	43
7.3	Lighting Strategy	44
7.4	Understanding Optics Squareness	45
7.4.1	Checking Optics Squareness.....	45
7.5	Other Performance Factors.....	45
8	System Maintenance.....	47
8.1	Performing Daily Inspections	47
8.2	Performing Weekly or Monthly Maintenance	47
8.3	Replacing the Fuses	48
8.4	Maintaining the Fan Filter.....	49
8.5	Verifying Calibration	50
8.5.1	Calibration Validation Procedure	50
8.6	Cleaning the System.....	52
8.6.1	Cleaning External Surfaces.....	52
8.6.2	Cleaning the Optics.....	52
8.6.3	Cleaning Mechanical Parts.....	53
8.7	Applying Lubrication	53
8.8	Accessing Components within the System	53
8.9	Spare Parts and Accessories.....	56
9	Glossary.....	59

1 About This Guide

1.1 Purpose

This guide provides instructions on how to install, operate, and maintain the HDV500 floor mounted horizontal digital video system. This guide also provides information on the various options and features available with the system.

1.2 Scope

This guide provides detailed information on the components, features, and specifications of the HDV500 system. This guide also includes operating and maintenance information for the system. High-level information is provided on unpacking and installation. HDV500 systems are intended to be installed by SKE Technical Service specialists or qualified third-party personnel.

1.3 Audience

This guide is intended for end-user customers, SKE Technical Services specialists, and authorized SKE technicians.

1.4 Prerequisites

You should have some knowledge of metrology systems and be familiar with customary system administration and field service practices.

1.5 Conventions

This guide uses the following three conventions to present information that requires special attention: a warning, a caution, or a note.

A warning looks like this:

<p style="text-align: center;">WARNING</p> <p>Warning information is printed in a box. Warnings direct your attention to operating or maintenance procedures or practices that must be followed correctly to prevent personal injury, loss of life and, possible, hardware or software damage.</p>
--

A caution looks like this:

<p style="text-align: center;">Caution</p> <p>Caution information is printed in a box. Cautions provide information that helps to prevent accidental hardware or software damage.</p>
--

A note looks like this:

Note: *Pay special attention to the information printed in italics that follows the **Note:** heading. Notes provide additional information that is important to the surrounding text.*

1.6 Disclaimer of Liabilities

The L.S. Starrett Company shall have no liability or responsibility to the customer or any other person or entity with respect to any liability, loss or damage caused or alleged to be caused directly or indirectly by this documentation, or the hardware and software described in it. This includes, but is not limited to, any interruption of service, loss of business or anticipatory profits, or consequential damages resulting from the use or operation of hardware or equipment.

1.7 Warranty

Starrett Kinematic Engineering, Inc. products carry a one-year (from date of purchase) warranty against defects in material and workmanship (parts and labor) subject to factory inspection. Parts not manufactured by Starrett Kinematic Engineering, Inc. (for example, computers, monitors, etc.) carry the original manufacturers' warranty. Starrett may also process warranty for these parts.

Starrett Kinematic Engineering, Inc. will repair or replace, at our option, any part or parts, which we find defective in workmanship or material. We will warranty repaired or replaced parts for the balance of the original warranty period or 90 days whichever is longer. This warranty will not apply to defects resulting from modifications made by the customer or improper use of the system or its components. If applicable, parts returned to the factory will be repaired at no charge. UPS Ground freight will be paid by Starrett. Freight other than UPS Ground can be requested and additional fees may apply.

This warranty does not cover damages from such causes as abuse, accident, neglect, fire, flood, electrical surge, or freight damage.

1.8 Copyright and Trademark Information

HDV500™ is a trademark of the L.S. Starrett Company. M3™ is a trademark of MetLogix, Inc. Windows® is a registered trademark of Microsoft Corporation.

1.9 Related Product Information

The following documents provide information that is related to the subject of this guide.

MetLogix M3 Video and FOV Inspection Software User's Guide

This guide provides detailed information on operating the M3 software that is included with HDV system.

HDV500 Floor Mounted Horizontal Digital Video System Unpacking Read Me First Instructions (8856)

This guide provides the information to safely unpack the HDV500 system.

2 Environmental and Regulatory Specifications

The following information provides the environmental and safety information for the HDV system.

2.1 Operating Environment Specifications

The following table provides the environmental specifications for the HDV system.

Feature	Specification
Calibration Temperature	20 ± 0.5°C (68 ± 1°F)
Allowable Operating Temp.	18-22°C (64-72°F), non-condensing
Environmental Protection	Positive pressure in enclosure provided by two fans with air filter

2.2 Calibration Environment Specifications

HDV500 systems are factory calibrated under the standard laboratory environmental conditions shown in the following table.

If the system is to be operated under environmental conditions that are substantially different from those provided, the system should be recalibrated under the expected conditions. Users should also consider the material characteristics of the parts under inspection, in particular coefficients of thermal expansion. Numerical compensation might be required when measuring parts under conditions different from those controlling the stated dimensional specifications for these parts.

Specification	Requirement
Ambient Temperature	20°C ± 0.5°C (68°F ± 1°F)
Humidity	40-60% RH
Temperature rate of change	0.5°C (1°F) per hour

2.3 Regulatory Compliance

The following information provides the regulatory and safety standards for the HDV500 system.



HDV500 metrology and inspection systems have been designed to comply with Council Directives 2006/42/EC - Machinery when installed and operated in accordance with this manual, and to carry the CE mark. HDV500 systems are certified by SKE to be free from hazardous materials per 2002/ 95/EC RoHS.

2.3.1 EMC Standards

The following information provides the EMC standards for the HDV system.

Standard	Description
EN 55011 Class A	Conducted Electromagnetic Emissions
EN 55011 Class A	Radiated Electromagnetic Emissions
EN 61000-4-2	Electrostatic Discharge (Contact)
EN 61000-4-2	Electrostatic Discharge (Air)
EN 61000-4-4	Electrical Fast Transients (Direct Coupled)
EN 61000-4-4	Electrical Fast Transients (Capacitive Coupled)
EN 61000-4-6	Radio Frequency Conducted Immunity (150 kHz-80 MHz)
EN 61000-4-5	Surge (for control computer, et al)
EN 61000-4-11	Voltage Dips, Short Interrupts and Voltage Variations Immunity

2.3.2 Safety Standards

The following information provides the safety standards for the HDV system.

Standard	Description
EN 292-1	Safety of Machinery, General Principles for Design (Referenced)
EN 60204	Safety of Machinery, Electrical Equipment of Machines
EN 12100	Safety of Machinery, Principles for Risk Assessment
OSHA 1910.147	The control of hazardous energy (lockout/tagout)

2.3.3 Safety Considerations

General Safety

HDV systems are designed for safety and proper ergonomics during normal use. Exercise caution when handling or moving the systems to maintain calibration and measurement performance. Disconnect all power sources prior to moving or working on the equipment. Consult SKE if you have any question regarding transporting, using, or maintaining the

systems. Follow standard safety protocols for electrical and mechanical equipment in addition to all guidelines outlined in this manual. Failure to exercise proper safety practices may result personal injury and equipment damage.

WARNING

Exceeding the maximum load capacity of 150 kilograms (330 pounds) significantly reduces accuracies of the system and might damage the mechanical structure.

Electrical Safety

HDV systems do not contain hazardous AC line voltages, as these are contained on the input side of the system's AC adapters, which are UL listed. Even at these low voltages, there is the potential of electrical component damage caused by accidental short circuits. For maximum electrical safety and minimal risk to the equipment, adhere to the following guidelines:

- Ensure that the power receptacles for the AC adapters are properly grounded 3-prong polarized 120V AC types for use in North America or appropriate safety-rated receptacles for use outside of North America.
- Do not operate the systems with housings open except for service by a factory trained technician.
- Disconnect all power sources prior to moving or working on the equipment.
- Keep liquids away from the systems, and do not operate the equipment in excessively humid conditions, as water can cause short circuits.
- Keep metal filings away from the systems, debris can cause short circuits.
- Do not operate the equipment around volatile or flammable solvents, as local electrical heating could cause ignition.
- Disconnect power, or do not plug in the power cord, if hazardous conditions exist such as a damaged or frayed power cord, a damaged or improperly grounded power receptacle, equipment exposure to liquid spills or excessive moisture, or impact damage. Have the system inspected by authorized personnel before operating.
- Control unexpected hazardous energy by using the detachable IEC (International Electrotechnical Commission) plug lockout device available with the system. The lockout device works as a block to prevent power going to the socket by simply plugging into the socket and twisting. To install the lockout device, refer to "Installing the Lockout Device" in Section 6 of this document.

Mechanical Safety

The HDV system has moving components and pinch points. Do not place hands and mechanical items near pinch points. Failure to observe this warning could result in personal injury and equipment damage.

3 The HDV500 System

This section provides the following information for the HDV500 system:

- An overview of the HDV500 system
- A description of the feature and capabilities of the HDV500 system
- A description of the major components of the HDV500 system

3.1 Overview

The HDV500 is a large horizontal digital video system that includes a 500-millimeter (19.7 inch) of stage travel, 150 kilogram (330 pound) load capacity, and a large 1067 millimeter (42 inch) diagonal video monitor. The HDV system provides a uniquely designed interchangeable lens mounting system to a hi-resolution 5 mega-pixel digital video camera. In addition, the CNC-capable system includes the powerful MetLogix M3 vision metrology software with the M3 DXF/FOV option pack.

3.2 Features and Capabilities

Key features and capabilities of the HDV system include the following:

- Delivers a rugged system that is equally at home in a quality lab or on the shop floor. The housing is made of welded steel. The stage is made of machined nickel-plated steel and has two dovetail slots to allow the clamping of parts and fixtures. Maximum workload capacity is 150 kilograms (360 pounds). Linear glass scales provide 0.5 μm (0.00002 inches) of resolution to read stage motion.
- Includes a 5-megapixel digital video camera that is available with a choice of three telecentric lenses for micron-level resolution and measurement distortion as low as 0.002% across the field of view (FOV) for accurate measurements. The lenses are mounted by means of a bayonet fitting and can be changed by the user in a matter of seconds.
- Includes a motorized CNC system, where motion and illumination are under computer control. Manual operation for setup and individual measurements is provided by means of a joystick.
- Includes MetLogix M3 vision metrology software with the M3 DXF/FOV option pack. With this software, the HDV500 can import DXF CAD files over a network and make automatic 2D go-no-go comparisons to an engineering design by using video edge detection (VED), with no need for the screen overlays that would be required with an optical comparator.
- Easy to use operator controls including joystick, wireless keyboard and mouse, and 42-inch touch screen monitor.
- Optional CNC rotary stage that provides increased radial load stability and moment load rating.

- Includes a computer and M3 controller that are located inside the housing, resulting in a clean design with minimal external wiring. The housing is maintained at a positive pressure by two filtered fans to minimize the entry of oil and dust particles in machine shop environments.

3.3 HDV500 System Components

The following information describes the key components of the HDV system. Refer to the following figure for the locations of these components.

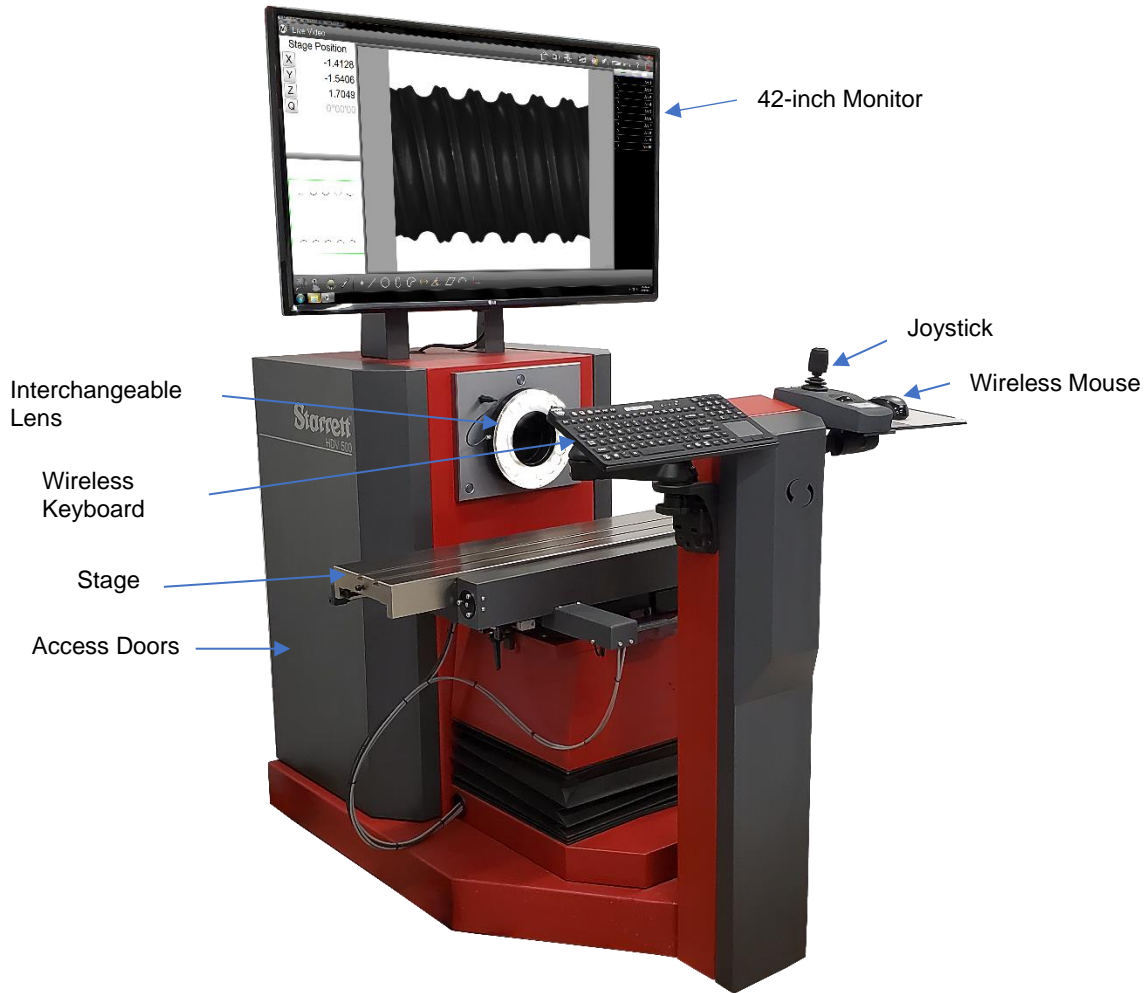


Figure 1. System Component Overview

3.3.1 Lens Options

Telecentric optics allow high accuracy, high throughput measurements within their field of view. For the highest throughput, select a telecentric lens with a field of view that encompasses the entire part to be measured. Or work at higher magnification, in which case M3 software will seamlessly combine FOV measurements with encoder readings from stage motion. The HDV500 system comes with a bayonet mount which allows telecentric optics to be changed by the user in seconds.

The following telecentric lenses are available with the system:

- 0.24X magnification with a 35 x 29 millimeter (1.4 x 1.1 inch) field of view
- 0.16X magnification with a 54 x 45 millimeter (2.1 x 1.8 inch) field of view
- 0.11X magnification with a 76 x 64 millimeter (3.0 x 2.5 inch) field of view



Figure 2. HDV500 Telecentric Lenses

3.3.2 MetLogix M3 Software

The HDV system includes the MetLogix M3 advanced metrology software. The software includes the following key features:

- **Advanced Video Probes:** The M3 software includes several probes that provide the ability to capture complex edges, enable instant feature determination and measurement with the single click, and an industry first video touch probe functionality.
- **Field of View Functions:** The field of view Auto Run function plays part programs to perform measurements quickly without operator intervention. Place one or more identical parts in the field of view and the system will identify the part, execute the appropriate program, and report measurement results.
- **Touch Probe Support:** M3 software includes support for multi-sensor video measuring systems equipped with touch probe modules. Expanded 3-D feature geometries are supported through touch probe and video measurement of features in the XY, YZ and ZX planes. Measure planes, cones, cylinders, and spheres in 3-D part space and then view results in the 3-D part view. Part views can be rotated with markups showing feature measurement results.
- **Multi-Touch Software Control:** In addition to the conventional mouse interface, expanded MultiTouch logic allows for one-touch feature measurements as well as versatile panning and zooming of the live video image and the active part view. This capability increases the efficiency of feature measurements, feature data manipulation, and reporting tasks with a simple pinch zoom, swipe pan, or double click.
- **Advanced Edge Teach:** This feature provides improved edge detection performance under a variety of image and lighting conditions. Features with poor edge contrast, or difficult spacing can be captured in a snap using the M3's manual teach function.
- **DXF Overlay and FOV Capability:** Using the DFX/FOV option pack, you can import DXF files for "comparative style" Go/No-Go feature and part inspection. This includes a live error whisker display for violations of the original DXF tolerance zones. DFX/FOV option pack features include:
 - Custom DFX crosshair
 - Feature-based video overlays
 - Import DFX overlay
 - Export features to DFX
 - Pattern teach and recognition
 - Live image "freeze"

For detailed information on the MetLogix M3 software, refer to the ***MetLogix M3 Video and FOV Inspection Software User's Guide***.

3.3.3 Operator Controls and Interfaces

The following information provides the controls and interfaces of the HDV system.

System PC

The HDV system includes a small form factor system PC where the M3 software is preinstalled and controlled.

Touch-screen monitor

The 42-inch touch screen monitor is used to control the M3 software. The monitor displays a live video image of the part in addition to geometry tools and digital readings. The image of the part can be resized using pan and zoom, and measurements are taken by simply tapping a feature on the screen.

Wireless keyboard and mouse

The HDV500 keyboard is environmentally sealed. It is used for programming, data entry, and program operation. It includes an integral touchpad, which serves the functions of a mouse. The system also includes a wireless mouse.



Figure 3. HDV500 Sealed Keyboard

Joystick

The joystick provides position control of the stage in the X, Y, and Z axes. The joystick includes functionality to stop the system, switch between axis movement, and control speed. The joystick can be used to operate the system manually for quick individual measurements and short runs.

For detailed information on operating the joystick, refer to “System Operations” later in this document.



Figure 4. Joystick and Wireless Mouse

3.3.4 Automatic and Manual System Operations

The HDV system allows fully automatic operation using the M3 software for the following operations:

- Illumination
- Right-left position of the stage (X-axis)
- Up-down position of the stage (Y-axis)
- In-out position of the stage (Z-axis, used for focus adjustment)

The system also allows manual operation for setup, for quick individual measurements, and for short runs.

- Manual control of front and back illumination through sliders on the computer screen using M3 software.
- Manual control of the X, Y, Z axes through the M3 software using the joystick.

3.3.5 Rotary Stage Option

The HDV system includes the option for the APT200 rotary stage. The rotary stage provides significantly increased radial load stability and moment load rating of up to 55.2 newton meters (Nm).

The APT200 rotary stage provides the following features:

- Includes a 182-millimeter diameter circular face
- Includes an axial load rating of 300 newtons (N)
- Minimized runout (wobble) and radial runout of 10 microns

- Provides repeatability to 2.0 arc seconds
- Operates at a maximum speed of 300 rpm
- Includes the option for vertical or horizontal mounting

For detailed information on the rotary stage specifications, refer to “System Specifications” later in this document.



Figure 5. ATP200 Rotary Stage in Vertical Mounting Position

4 System Specifications

This section provides the performance, mechanical, electrical, and component specifications for the HDV500 system.

4.1 Performance

The following table provides the performance specifications for the HDV500 system.

Feature	Specification
Stage Travel, X (left-right)	500 millimeters (19.7 inches)
Stage Travel, Y (up-down)	200 millimeters (7.9 inches)
Focus Range, Z (front-back)	70 millimeters (2.8 inches)
Maximum Object Height	250 millimeters (9.8 inches)
Scale Resolution, X & Y	0.5 μm (0.00002 inches)
Reading Accuracy, X & Y	$E2 = 3.0\mu\text{m} + L/33$ millimeters
Stage Load Capacity	20 kilograms (44 pounds) for negligible deflection, 150 kilograms (330 pounds) max
Helix Angle Skew Adjustment	+5° clockwise, -15° counter-clockwise
Helix Angle Readout	Protractor Vernier scale for 5' angular resolution
Motion Control	Full CNC control or motorized manual control via joystick

4.2 Mechanical

The following table provides the mechanical specifications for the HDV500 system.

Feature	Specification
Mounting Location	Floor mount
Height to Top of Monitor	1800 millimeters (70.9 inches) (max)
Height to Center of Monitor	1460 millimeters (57.5 inches) typical, ± 90 millimeters (3.5 inches) adjustment range.
Width	1330 millimeters (52.4 inches) (at extremes of stage travel)

Feature	Specification
Depth	1345 millimeters (53 inches)
Monitor Dimensions	565 x 975 x 64 millimeters (22.3 x 38.4 x 2.5 inches)
Height of Center of Monitor	0 to 250 millimeters (0 to 10 inches), adjustable
Stage Material	Steel, machines, nickel plated
Housing Material	Steel, welded, powder coated
Stage Area	820 x 200 millimeters (31.3 x 7.9 inches)
Shipping Weight	770 kilograms (1700 pounds), approximately

4.3 Illumination

The following table provides the illumination specifications for the HDV500 system.

Feature	Specification
Surface Illumination	190 millimeters (7.5 inches) diameter LED ring light mounted around body of lens
Contour Illumination	112 millimeter (4.4 inches) collimated LED backlight

4.4 Optical

The following information provides the optical specifications for the HDV500 system.

Feature	Specification		
Operator Display	1067 millimeters (42 inches) diagonal monitor, backlit LED, 1920 x 1080 pixels		
Monitor Display Area	930 x 523 millimeters (36.6 x 20.6 inches)		
Monitor Pixel Size	0.36 x 0.36 millimeters (0.014 inches)		
Camera Type	Industrial camera, USB 3.0, 5 megapixels (2448 x 2058) on 2/3-inch array		
Camera Lens Mount	Quick-change bayonet		
Telecentric Lens Magnification	0.24X	0.16X	0.11X
Telecentric Lens Field of View	34.7 x 29 mm (1.3 x 1.1 inches)	53.8 x 45 mm (2.1 x 1.7 inches)	76.5 x 64 mm (3.0 x 2.5 inches)

Feature	Specification		
Magnification on Monitor (1:1 pixel setting in M3 software)	14.7X	9.3X	6.5X
Visual Resolution on Monitor	18 line pairs/mm	13 line pairs/mm	10 line pairs/mm
Repeatability in FOV, 3 Sigma			
Optical Distortion ($\Delta H/H$)	0.04%	0.03%	0.02%
Software Corrected Distortion	0.004%	0.003%	0.002%
Telecentric Depth of Field (split 1/3 front, 2/3 back)	16 mm (0.63 inches)	37 mm (1.46 inches)	52 mm (2.05 inches)
Telecentric Lens FWD	150 mm (9.0 inches)	159 mm (6.3 inches)	228 mm (9.0 inches)

4.5 Operator Controls

The following table provides the operator controls for HDV500 system.

Feature	Specification
Computer Interface	42-inch color monitor, sealed keyboard with touchpad, wireless mouse
Other Operator Controls	Two on-off switches, Emergency Stop switch, joystick, wireless mouse

4.6 Electrical

The following table provides the electrical specifications for the HDV500 system.

Feature	Specification
Power Supply Location	Inside main housing
Voltage Requirement	120/240V AC
Power Requirement, Main Unit	300W peak, 200W typical
Power Requirement, Monitor	60W typical

4.7 Computer and Software

The following table provides the computer and software specifications for HDV500 system.

Feature	Specification
Form Factor	Board level computer housed inside comparator enclosure
Computer Hardware	64-bit CPU, Intel Core i7 256 GB M.2 SSD hard drive
Network Interfaces	Externally accessible Ethernet port, 3 USB 2.0 ports
Operating System	Windows® 10 Professional
Metrology Software	MetLogix M3 software with FOV/DXF option pack

4.8 Rotary Stage Option

The following table provides the specifications for the APT200 rotary stage option. See Section 3, “HDV500 System Components” for additional information on the rotary stage.

Note: The APT200 rotary stage is an option and does not come standard with the HDV500 system.

Specification (Units)	APT200
Rotational Accuracy (arc-sec)	±2
Load Capacity, Axial (Kg)	30.6
Load Capacity, Radial (Nm)	55.2
Maximum Speed (RPM)	300
Runout (µm)	10

5 Installing and Setting Up the System

This section provides the following information on the HDV system:

- Planning the placement of the HDV system
- Uncrating and moving the system to the desired location
- Removing the stage locks
- Installing the stage cover
- Setting up the video monitor

SKE metrology systems are normally installed by factory-trained technicians who also provide operator training. The following information covers basic hardware installation if an installer is not available. Refer to “On-Site Installation, Calibration and Training” later in this section for more information on SKE installation and calibration services.

5.1 Planning the Placement of the System

HDV systems are normally placed directly on a concrete floor in a work area. Following are recommendations for planning the placement of the HDV system:

- Select a location where the temperature can be controlled to within $20^{\circ}\text{C} \pm 0.5^{\circ}\text{C}$ ($68^{\circ}\text{F} \pm 1^{\circ}\text{F}$), which is the calibration temperature of the system.
- Select a location that is free from oil fumes, dust, and debris. Contaminants can coat critical mechanical and optical parts, which require more frequent system maintenance.
- Ensure a grounded 2-phase electrical power outlet is located close to the system.
- Allow enough clearance around the machine as follows:
- Allow at least 200 millimeters (7.9 inches) to the rear for access, and 600 millimeters (23.6 inches) or more to the sides.
- The width required for maximum X-axis stage travel is 1330 millimeters (52.4 inches). Consider the longest parts to be measured or inspected, since large parts can overhang beyond right or left sides of the stage.
- Allow room for the staging of incoming and outgoing parts.

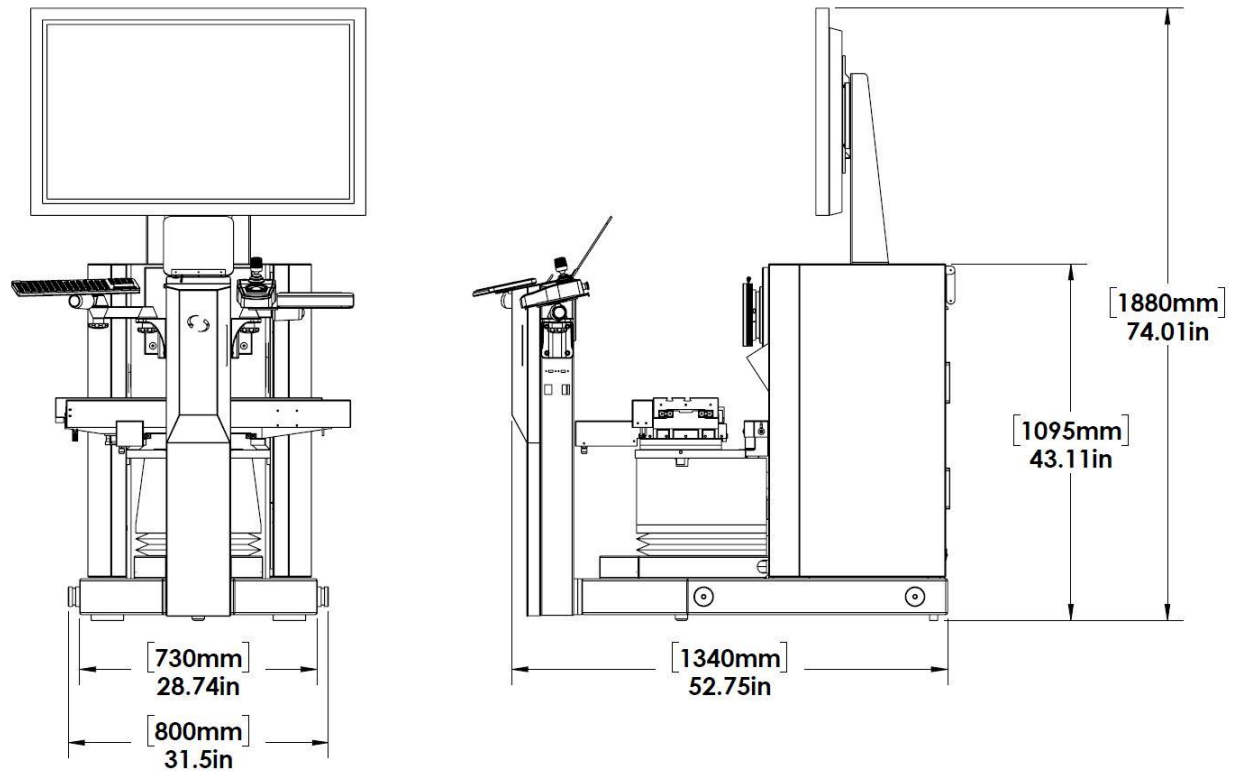


Figure 6. HDV500 Dimensions

5.2 Moving and Uncrating the Equipment

WARNING

The shipping weight of the HDV500 system is 1700 pounds (770 kilograms). The system must be moved and positioned by a professional rigger (or rigging company) with specialized skills and equipment to move and position heavy and large machinery.

HDV500 systems are normally shipped in single wooden crate. To uncrate the equipment, refer to the following figures and perform the following steps:

1. Use a reversing battery powered drill with a Phillips bit, remove all wood screws from the top of the crate, then lift off the top.
2. Remove all wood screws from the side panels of the crate, then remove the side panels. This action exposes the HDV500 main unit on the shipping pallet and the 42-inch video monitor, which is shipped uninstalled in the same crate.



Figure 7. Removing the Screws from the Shipping Container

3. Use a wrench to remove the four L-shaped brackets that secure the HDV500 main unit to the shipping pallet.



Figure 8. L-Shaped Bracket

The main unit can now be lifted by the rigging company using the four red bosses which extend from the base.

5.3 Removing the Stage Locks

The HDV system is shipped with X, Y, and Z stage locks to prevent movement during shipment. The stage locks must be removed once the equipment has been placed in its final position.

1. Locate the stage locks using the following information and figures.
 - The X-axis lock is located on the left of the stage.
 - The Y-axis lock is located under the lens mount.
 - The Z-axis lock is located near the X-axis drive motor.



Figure 9. X-Axis Stage Lock

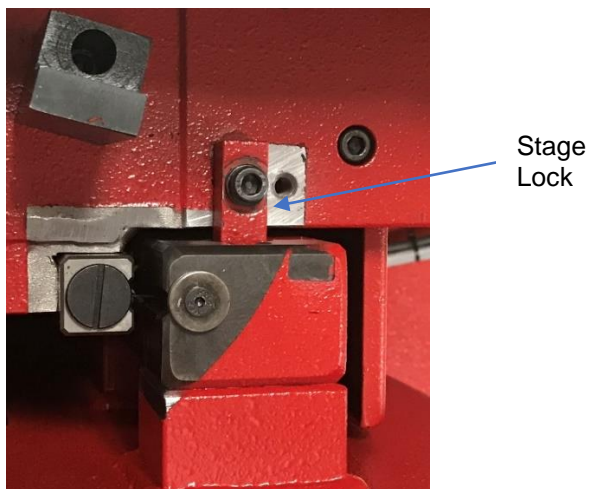


Figure 10. Y-Axis Stage Lock



Figure 11. Z-Axis Stage Lock

2. Using a metric hex wrench, remove the screws that secure the lock. Repeat this step for each of the stage locks.

5.4 Installing the Y-Axis Stage Cover

In addition to removing the stage locks, the Y-axis stage cover must be installed on the system. To install the stage cover, perform the following steps and refer to the figures:

1. Locate the Y-axis stage cover that is shipped with the system.



Figure 12. Y-Axis Stage Cover

2. Put the stage cover in the place, directly under the lens, and attach with the screws included.



Figure 13. Y-Axis Stage Cover Screws



Figure 14. Installing the Y-Axis Stage Cover

5.5 Mounting and Connecting the Video Monitor

To mount and connect the video monitor, refer to the following figure and perform the following steps:

1. Mount the 42-inch video monitor, which is held by a commercial articulating arm wall-mount mechanism. Select a mounting height for the system's principal operator.



Figure 15. Video Monitor with Articulating Arm Wall-Mount Mechanism

2. Make the following electrical connections to the 42-inch video monitor:
 - a. Insert the power cable.
 - a. Insert the HDMI video cable into the position marked HDMI 1 IN.
 - b. Plug in the AC power cable to the back of the main unit.



Figure 16. Video Monitor Cable Connections

6 System Operations

This section provides the following information on operating the HDV500 system:

- Using automatic system operations
- Using manual system operations
- Powering the system On and Off
- Verifying basic M3 software operations
- Installing the lockout device
- Removing and replacing the lenses
- Verifying the setup of the system

6.1 Using Automatic System Operations

The HDV500 system allows fully automatic operation through the M3 software. For detailed information on automatic system operations refer to the ***MetLogix M3 Video and FOV Inspection Software User's Guide***.

6.2 Using the Manual System Operations

The HDV500 system also allows manual operation for setup, for quick individual measurements, and for short runs using the joystick, keyboard, and mouse.

6.2.1 Using the Joystick to Control Operations

Caution

Be careful not to knock the joystick unit to the floor, as it can break.

Note: *The joystick unit is held by friction in a cradle at the top of the contour illumination post. The joystick can be rotated or removed for hand-held, tethered operation.*

The following table provides the functionality of the joystick. Refer to the following figure for the location of the controls.

Control	Function
Emergency stop switch	Press to stop all CNC motion
Button 1	Speed toggle. Located on the top of the joystick. Press once for slow speed for the control. Press again for normal speed.
Button 2	Axis lock. Press for motion along one axis only. Press again to allows diagonal motion.

Control	Function
Button 3	Z-Toggle. Press for Z-axis control by the trackball. Press again for Z-axis focus control or Q-axis rotary stage control using the joystick.
Button 4	Go To Here. Press to lock in coordinates when programming.
Button 5	Enter. This button functions the same as the Enter key on a PC keyboard.
Joystick deflect right to left	Moves the Z column from right to left (X-axis control).
Joystick deflect front to back	Moves the stage front to back (Y-axis control).
Joystick rotate	Moves the Z column up and down (Z-axis control) or provides Q-axis control.
Trackball	Rotate for fine tuning X and Y positions, or for fine tuning Z-axis focus as set by Button 3.



Figure 17. HDV500 Joystick Unit for Manual Operator Control

6.2.2 Using the Keyboard and Mouse Controls

The HDV500 keyboard and mouse are used for programming, data entry, and program operation. Refer to the following table for functionality. Refer to the following figures for additional information.

Control	Functionality
Keyboard Touchpad	Used to move the cursor, replacing the functionality of a mouse. Slide your fingertip along the surface to move the cursor on the screen.
Two keys below the touchpad	Provide left-click and right-click functionality, similar to a mouse.
Keyboard swing-out arm	Used to adjust the position of the keyboard: left-to-right angle or up-down tilt angle.
Wireless mouse	Used to move the cursor.



Figure 18. Keyboard



Figure 19. Joystick and Wireless Mouse

6.2.3 Adjusting the Keyboard

The articulated arm that holds the keyboard can be adjusted to best suit your working habits. By default, the keyboard is mounted to the left side of the contour illumination post, but a mounting location to the right side of the post can be specified at the time order. Refer to the following figure for information on the knobs and levers used to adjust the keyboard position.



Figure 20. Adjusting the Keyboard

6.3 Controlling Power to the System

HDV500 systems are equipped with three power switches. Refer to the following figures.

- A rocker switch on the back of the unit adjacent to the 115/ 230V power connector as required for CE certification. This switch supplies power to the two power switches on the front column of the system. Refer to the following figure.



Figure 21. Power Entry Module at Rear of the System

- Two rocker switches on the front column of the system labeled PC Monitor Power and M3 Amp Power.
- The switch labeled PC Monitor Power supplies power to the PC and monitor.
- The switch labeled M3 Amp Power provides power to the remaining components in the system.

For normal operation, the rocker switches should always be in the On position marked "I". Refer to the following figure.

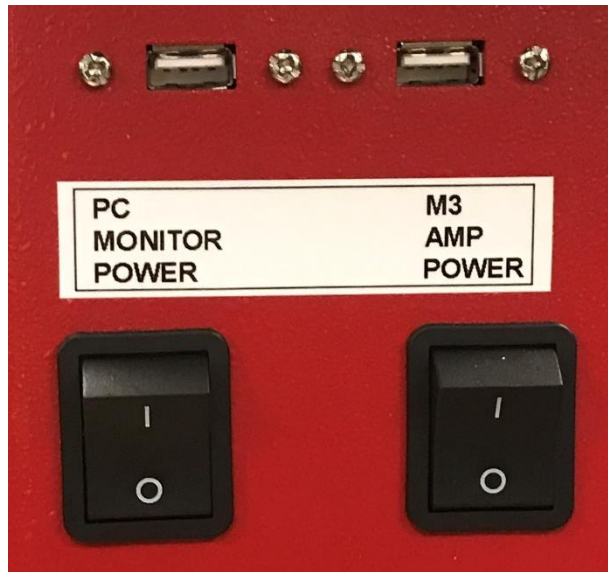


Figure 22. Power Control at the Front Column of the System

6.3.1 Powering Up the System

To apply power and start the system, perform the following steps:

1. Push the Power switch at the rear of the system (Figure 21) to the position marked "I" (On).
2. Push the PC Monitor Power and M3 Amp Power rocker switches (Figure 22) to the position marked "I" (On).
This action enables the built-in PC to self-boot and come up in Windows.
3. Launch the MetLogix M3 software by clicking on the M3 icon on the monitor.
4. Proceed to "Verifying Basic M3 Software Operations" later in this section for information on initializing the M3 software.

6.3.2 Powering Down the System

Caution

Before removing power, first shut down the computer in software. This ensures that all files are properly closed.

To power down the system, perform the following steps:

1. Close all computer files and applications.
2. Shut down the computer using the Windows “Shut down” function.
This action prevents computer files from corruption by the sudden loss of power.
3. After the computer has been properly shut down, push the PC Monitor Power and M3 Amp Power rocker switches to the position marked “O” (Off).
4. Push the rear power switch to the position marked “O” (Off).

6.4 Verifying Basic M3 Software Operations

The following information provides basic instructions for operating the M3 software. For detailed information, refer to the ***MetLogix M3 Video and FOV Inspection Software User's Guide*** included with your system.

To start the M3 software, perform the following steps:

1. Double-click the M3 software icon on the desktop. Refer to the following figure.



This action displays the interface below.



2. Select Start or touch the Start button on the screen. X, Y, and Z-axes are automatically homed.

Once the machine is homed, the screen indicates the machine is homed and there is a green checkmark in the upper right corner of the screen. Touch or click on the screen.



For accurate measurement, this checkmark must be green before proceeding.

6.5 Installing the Lockout Device

An optional component available with the HDV system is a lockout device that is used to control unexpected hazardous energy. The lockout device works as a block to prevent power going to the socket.

Note: To purchase the lockout device, refer to “Spare Parts and Accessories” later in this document.

To install the lockout device, refer to the following figure and perform the following steps:

1. Locate the power entry module at the rear of the system. Refer to Figure 23.
2. Install the lockout device onto the power connector.
3. Twist the “key” clockwise to set the device in place.
4. Attach the safety tag to the padlock and insert the padlock into the opening on the lockout device.
5. Remove the key and retain the key in a safe location.



Figure 23. Installing the Lockout Device

6.6 Removing and Replacing the Lenses

Cautions

- Do not leave the camera unprotected by a lens assembly to minimize dust settling on the sensor surface.
- Do not touch optical surfaces. Oil from your hands can permanently damage optical coatings.
- Handle the lenses with extreme care. Lenses are breakable and very expensive.
- Place unused lens assemblies in a sealed bag or enclosure for dirt protection.

Removing Lens from the System

To remove an installed lens, refer to the follow figures and perform the following steps:

1. Remove the LED ring light that is attached to the lens as follows:
 - a. Loosen the black knurled nut that holds the electrical cable connector to the main unit and then pull out the cable connector.
 - b. Pull off the ring light and set it aside. The ring light is magnetized to the lens.

Caution

Use both hands to hold and remove the lens. The lens is spring loaded and will detach from the lens mount with force.

2. With the ring light removed, use both hands to turn the lens a few degrees clockwise, pull it out from its bayonet fitting, and set it aside.



Figure 24. Ring Light

Installing a New Lens

To install a different lens, refer to the following figures and perform the following steps:

1. Locate the red dot on the lens and the red dot on the lens mount. These dots are used to properly align the lens.
2. Insert the new lens and ensure the red dots align.
3. Turn the lens clockwise until the lens locks into place.
4. Reposition the ring light around the lens. The ring light is attached magnetically with four magnets on the lens.
5. Reconnect the ring light by inserting the cable connector and tightening the black knurled nut that holds the electrical cable connector in place.

The black cable connector is keyed so that the two connector pins can only be inserted in one orientation.

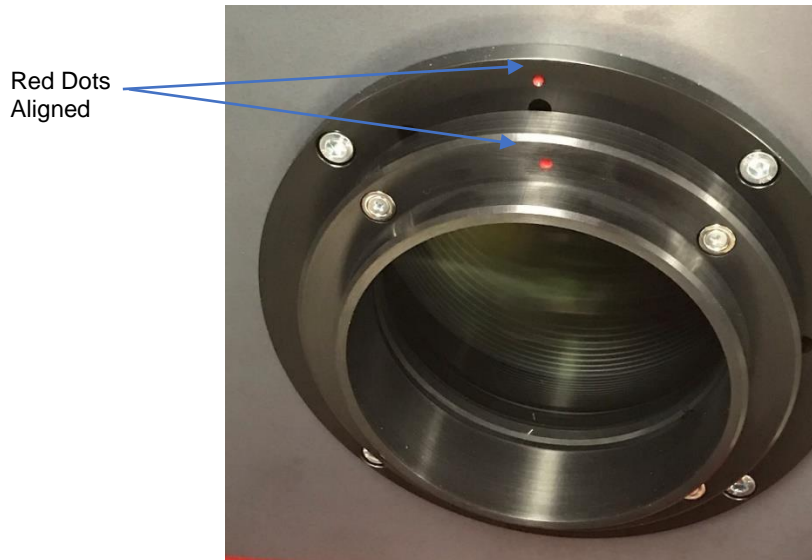


Figure 25. Aligning a New Telecentric Lens

6.7 Using the Communication Ports

Two USB ports are located above the power switches. See Figure 22 previously in this section. An additional USB port and an Ethernet port are located at the back of the unit. These ports are connected to the system computer and are supported by the Microsoft Windows operating system. The USB ports are typically used for external data storage devices and computer peripherals, such as printers. The Ethernet port is typically used for connection to a company's local area network (LAN).



Figure 26. USB and Ethernet Ports on the Rear of the System

6.8 Verifying the Setup of the System

Before using the system to measure parts, verify the following steps to ensure proper mechanical and measurement functions:

1. Check that the operator controls and M3 software are running properly. Refer to “Verifying Basic M3 Software Operations” earlier in this document.
2. Check the lighting controls. Refer to “Illumination Strategy” later in this document.
3. Check the system optics and ensure the optics are appropriate for the measurement being performed. Refer to “Understanding Measurement Strategy” later in this document.
4. Check that the general operating condition guidelines are observed. Refer to “Daily Inspection” later in this document.
5. Check optical squareness. See “Checking Optical Squareness” in the System Maintenance section.
6. Check calibration. See “Calibration Verification” in the System Maintenance section.
7. To validate that the system is in proper working order, take an artifact of known size and measure the features utilizing the system controls. Once validated, the system can be used on actual parts.

6.9 On-Site Installation, Calibration, and Training

All Starrett vision metrology systems and optical comparators are calibrated at the factory prior to shipment; however, it is possible that components might have moved during shipment. A complete functional test and calibration are recommended following physical installation.

Professional system installation is normally provided by Starrett Factory Service Technicians or Starrett Authorized Service Technicians for all new vision metrology systems and optical comparators sold in North America. Installation can include equipment setup, on-site calibration, and on-site operator training. While professional installation, calibration and training are separately quoted line items, these services are highly recommended and are purchased by most users.

Starrett setup can include the following services:

- Overseeing the equipment's in-plant transportation to its permanent location and uncrating.

Professional "riggers" might be required for large format floor standing models like the HDV500. This typically takes one day for an HDV500 system. The system should then be allowed to temperature stabilize overnight prior to calibration.

- Performing the physical setup and electrical connection of the system.
- Completing functional checkout.
- On-site calibration

On-site calibration normally takes place on the day following setup. Calibration uses NIST-traceable glass grids, linear standards, and gage blocks. Calibration typically takes 1/2 day for a CNC system like the HDV500. If a motorized rotary stage is purchased with the HDV500, then additional installation, set-up and calibration is required which can add another 2 hours of technician time plus the appropriate calibration equipment.

- On-site basic operator training

Training can be provided following calibration. This typically takes one day for a CNC system like the HDV500. Many customers choose to augment basic CNC training with one or two days of specialized hands-on training, where new operators program actual parts of the type on which they will be working. Training is with the new equipment and is usually limited to one to three people, so that these can all get hands-on time. Starrett's objective is to create power users, who can then train other users when needed.

Technical services in North America (USA, Canada and Mexico) are provided by professional installers and service technicians operating out of the Laguna Hills, CA, headquarters of Starrett Kinematic, its regional sales offices, and its Starrett Authorized Service Partners. Outside of North America, Technical services are provided by Starrett subsidiaries in Brazil (for South America), Scotland (for Europe and Africa), China (for Mainland China), and Singapore (for Southeast Asia and Australia).

6.9.1 Contacting Starrett Kinematic Technical Support

To contact Starrett Kinematic for additional services, training, or technical support issues, visit www.starrettmetrology.com. From the Starrett Kinematic service site you can the following:

- Request technical support through our ticketing system.
- Register your system.
- Download User Manuals.
- Access our Starrett Kinematic Knowledge Base for answers to frequently ask questions.
- Learn more about the installation, service, and training services available.

7 Understanding the Measurement Strategy

HDV systems are available with telecentric, fixed-focus lenses with magnification options of 0.24X, 0.16X, 0.5X, and 0.11X.

Magnification is the image size at the camera charge coupled device (CCD) detector plane divided by the object size. Since the CCD size is fixed, each magnification has a corresponding field of view (FOV), which is the CCD size divided by magnification. The higher the magnification, the higher the resolution, but also the smaller the field of view.

The following information discusses the measurement strategy for the optics.

7.1 Telecentric Lens Magnification Strategy

Telecentric optics allow high accuracy, high throughput measurements within their field of view. For highest throughput, select a telecentric lens with a field of view that encompasses the entire part to be measured. The 0.11X lens can accommodate parts up to 76 x 64 millimeter (3.0 x 2.5 inch) in size. If the entire part cannot fit into the field of view, no problem. Simply move the stage by up to 500 millimeters (20 inches), and the M3 software will seamlessly combine FOV measurements with encoder readings from stage motion. Note that stage motion will increase the measurement time.

7.2 Focus Strategy

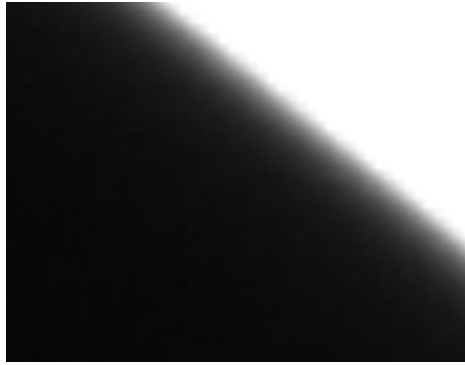
Always work at best focus. Focus is determined by adjusting the horizontal Z distance from the lens to the workpiece. To set focus, move the stage from front to back until you find the two points on both sides of the point of best focus where the image just starts to defocus. The point of best focus will be approximately midway between these two points.

7.2.1 Measurement Accuracy and Depth of Field

Telecentric lenses have a large focus range, also known as depth of field. Within this range, the instrument is expected to measure with an accuracy of about ten microns or better for a one-inch artifact.

However, the most repeatable results can be achieved by taking the time to adjust focus using digital zoom.

To do this, digitally zoom in on an edge and adjust focus until the pixels appear on that edge. This will ensure the best and most repeatable measurements are obtained. See the images below.



Poor Focus



Good Focus

7.3 Lighting Strategy

Once the image has been properly focused, adjust front and back lighting using the on-screen sliders provided by M3 software. You can also utilize room lighting, or shield the system from room lighting, as appropriate.

Correct lighting is paramount to accurate measurement with any video-based measurement system. A clear image with lighting toward the low side is recommended. Lighting that is too low will result in a dark, low-contrast image with indiscernible features. Lighting that is too bright might result in a washed-out image and in hot spots (or blooms) that provide false edges.

When adjusting lighting, start with light that is lower than desired, then increase lighting while viewing the image on the computer monitor. Maintain constant lighting for consistent results. Do not change light levels between points used to measure the same geometrical feature.

7.4 Understanding Optics Squareness

Caution

Optical alignment verification can be performed by any qualified operator. However, optical alignment correction should only be performed by an authorized technician. Report any observed alignment discrepancies and contact the factory or your local Starrett representative to schedule authorized service.

Squareness refers to the alignment of the camera relative to motion of the metrology stage. If the camera is misaligned (out of square), the image will appear to drift diagonally across the video screen as the stage position is moved along one axis. X-axis squareness is adjusted at the factory by rotating the camera with the stage skew to exactly 0° as read on the Vernier scale.

7.4.1 Checking Optics Squareness

To check optics squareness, perform the following steps:

1. Place the magnification (MAG) checker or other suitable inspection part on the stage and secure properly.
2. Select the crosshair image tool in M3 software and verify that it is at its defined center position. Refer to the ***MetLogix M3 Video and FOV Inspection Software User's Guide*** for details.
3. Select a point-like feature such as a corner or the standard's X-Y origin. Using the stage, position it to the center of the crosshair.
4. While observing the feature, slowly move the stage X axis only. (Do not move the stage Y axis.) Verify that the point remains aligned on the X axis of the crosshair as the feature is moved to the left and right within the field of view.
5. Report any observed discrepancy. If the error is verified, contact your Starrett representative for authorized service. A temporary fix for X-axis squareness errors is to adjust the skew of the stage.

7.5 Other Performance Factors

Following are some additional factors to consider:

- Keep the optics clean to avoid false shadows and artifacts.
- Avoid vibration.
- Use the calibration and shape correction algorithms available with M3 software, as described in the ***MetLogix M3 Video and FOV Inspection Software User's Guide***.

8 System Maintenance

HDV500 floor-standing digital video systems are rugged machines that have been designed for years of superior service. Periodic maintenance outlined in this section should be performed to maintain your system in peak operating condition.

This section provides the following information:

- Performing daily inspections
- Performing weekly or monthly inspections
- Replacing faulty parts
- Performing calibration verification
- Cleaning the system

8.1 Performing Daily Inspections

Each day, inspect your system for general safety and basic functionality:

- Verify that the work area is clean, dry, and free of debris. Remove any debris or loose items from around the system and metrology stage.
- Verify that the electrical power cord is plugged into a grounded power source and is unobstructed.
- Verify that temperature and humidity are within recommended ranges.
- Allow the system to warm up to normal operating temperature before performing critical parts measurements.

8.2 Performing Weekly or Monthly Maintenance

On a weekly or monthly basis (based on experience), do the following:

- Inspect the two fan filters. If dirty, wash or replace the filters.
- Inspect the system for cleanliness. If dirty, follow cleaning instructions stated under "Cleaning" later in this section.
- Verify that the stage control mechanisms move freely. Lubricate as needed or every 6 months, as stated later under "Lubrication" later in this section.
- Check the system for calibration against a chrome-on-glass standard such as Starrett's calibration standard.

8.3 Replacing the Fuses

Background

There are two fuses in the power entry module at the back of the unit. This module also incorporates the system's master On/Off switch and an EMI/RFI electrical filter. If power is properly applied to the system but the electronics are not energized, the problem might be due to a blown fuse.

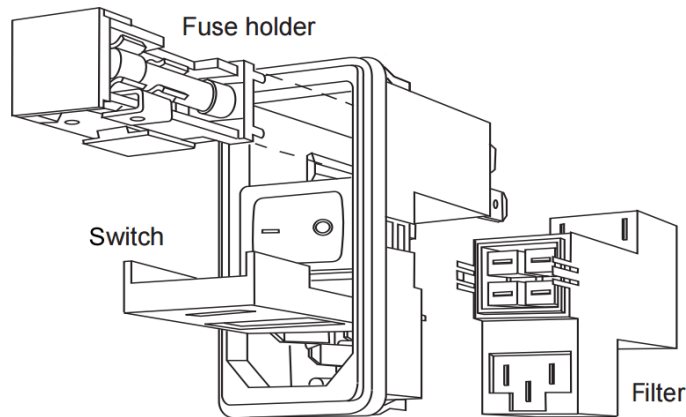


Figure 27. HDV500 Power Entry Module

Procedure

To check and replace fuses, refer to the following figure and perform the following steps:

WARNING

If work is to be done inside of the metrology unit or on the power entry module, always first unplug the 115V or 230V power cable to remove dangerous line voltages.

1. Unplug the power cable from the power entry module.
2. Pry open the cover above the power switch by using a small flat-blade screwdriver.
3. Pry out the red fuse holder by using the small flat-blade screwdriver.
4. Check the existing fuses for electrical continuity.
5. Replace any blown fuse with a fresh fuse of the same size and type. The fuse holder can hold two 5 x 20 millimeter or 1/4 x 1-1/4 inch, 5A, 250 VAC time delay fuses.
6. After replacing the fuses, press in the red fuse holder.
7. Press the cover above the power switch.
8. Plug in the power cable.

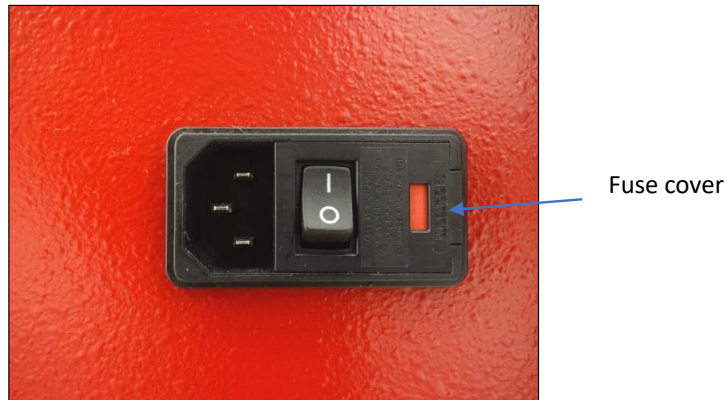


Figure 28. Power Entry Fuse Location

If fuses keep blowing, there might be a more serious electrical problem, such as an electrical short. Contact SKE Technical Support.

8.4 Maintaining the Fan Filter

The back of the system includes two 120-millimeter (4-3/4 inch) fans, which suck in ambient air through a filter element and maintain a slightly positive pressure inside the housing. While the system is running, filtered air comes in contact with the electronics.

The fan filters should be inspected weekly for cleanliness. If found dirty, they can be washed in hot water or be replaced.

- To inspect each filter, pry off the fan bezel with a flat-blade screwdriver and remove the filter, which is held by the bezel.
- To reinstall the filter, reseal it in the bezel and press the bezel back in place. Fan filters and the fan itself are user-replaceable items.

Fan filters are readily available from electronics distributors and computer stores. When purchasing a new fan, ensure that its voltage is the same as the voltage marked on the old fan.

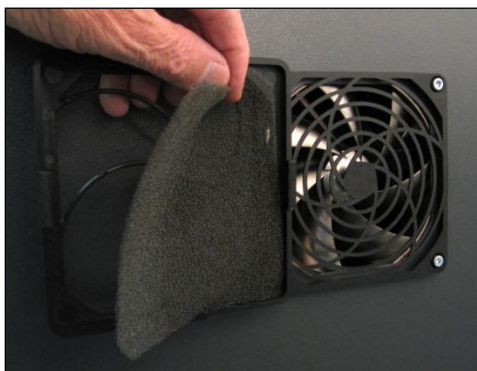


Figure 29. Replacing the Fan Filter

8.5 Verifying Calibration

Calibration should be verified periodically depending on user requirements and system use. At a minimum, calibration should be verified monthly. Calibration should also be verified after the system has been serviced or moved. NIST-traceable calibration standards are available from Starrett including a line standard and a calibration grid. Refer to “Spare Parts and Accessories” later in this document for ordering information. The following is a brief description of the steps recommended for the verification of your system.

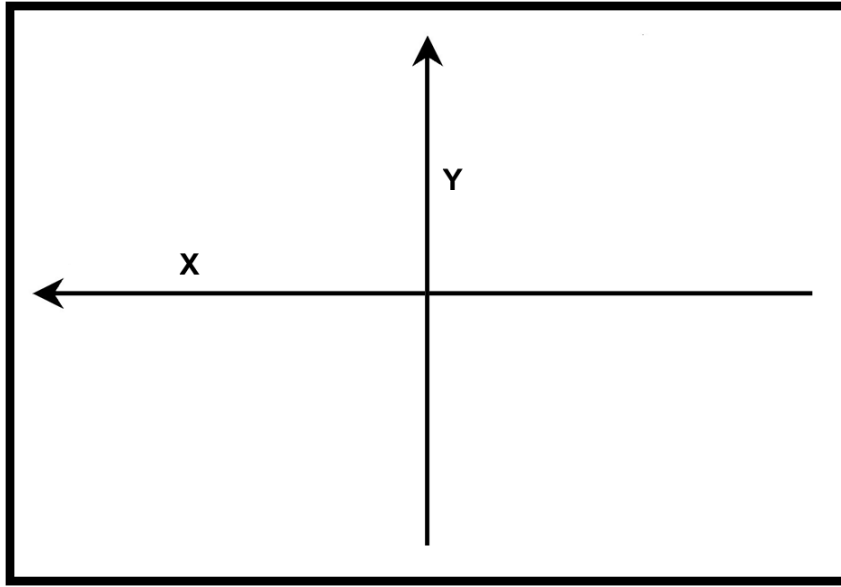


Figure 30. X and Y Calibration Axes

8.5.1 Calibration Validation Procedure

To validate calibration, perform the following steps:

1. Place the calibrated standard along the X axis. Secure the standard to the stage with a holder (available from Starrett, part number 7430).
2. Skew the center of the two end circles of the calibration standard. Refer to the **MetLogix M3 Video and FOV Inspection Software User's Guide** for proper alignment procedure.
3. Using the HDV system, measure the position of fiducials spaced every 25 millimeters. For each fiducial, take the average of multiple readings for improved accuracy.
4. Calculate the absolute measurement error for each fiducial by subtracting the calibrated position of the fiducial from the above average readings.
5. Verify that the calculated absolute X measurement errors are within the HDV system accuracy specification, which is $E2 = 3.0 \mu\text{m} + L/33 \text{ mm}$.
6. Repeat for the Y axis.
7. Enter the absolute X and Y errors on an X-Y Axes Accuracy Validation Results Plot, as shown below.

In this plot, the straight line defined by blue diamonds \blacklozenge is the maximum error specified by $3.0\ \mu\text{m} + L/33\ \text{mm}$. The green squares \blacksquare are the absolute X errors. The red triangles \blacktriangle are the Y errors. The HDV system is within the factory calibration specification if all X and Y errors fall below the straight line.

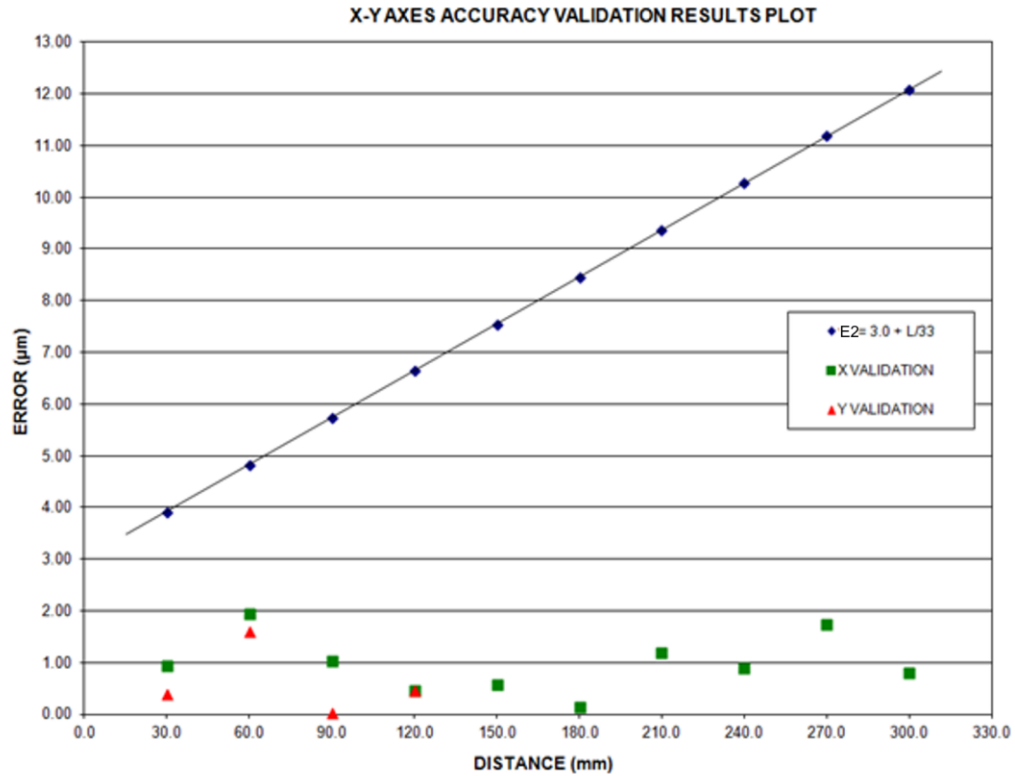


Figure 31. Sample Accuracy Validation Results Plot

8.6 Cleaning the System

WARNING

Never pour fluid on the system when cleaning. Do not over-wet the cleaning cloth. Excessive moisture can seep into mechanical or electrical parts, damaging the equipment and possibly causing an electrical short circuit and physical injury. As a precaution, unplug the system before cleaning. Always unplug the system before using any flammable cleaning fluid.

To the degree possible, the system should be kept in a clean environment, away from dirt, dust, oil, and debris which could affect system performance or degrade the system's mechanical and electronic parts. If a clean environment is not available, the machine should be kept as clean and protected as is possible. In harsh environments, preventive maintenance and factory service should be scheduled more frequently to keep the system in top working order.

8.6.1 Cleaning External Surfaces

Wipe down with a clean, lint-free cloth moistened (not wet) with plain water or Simple Green®. Never wipe down with acetone or other harsh solvents, which can damage painted or plastic surfaces. Isopropyl alcohol can be used to clean surface contaminants where Simple Green proves ineffective.

8.6.2 Cleaning the Optics

WARNING

Do not touch lens surfaces with your fingertips. Fingerprints can destroy optical coatings over time. Only clean optical surfaces with proper cleaning supplies, and then only when necessary.

To clean the lens, refer to the following guidelines and perform the following steps:

- If a lens is covered with loose dust, do the following:
 1. Use a can of optical grade (oil-free) canned compressed air to blow off the dust. Be careful not to shake the lens, or propellant might blow onto the lens.
 2. Use a lens brush to gently wipe off the dust.
- If the lens is soiled with greasy deposits which cannot be blown or brushed off, use an alcohol based commercial lens cleaner and a lens cleaning tissue or a lens cloth. These items are available from camera stores.
 1. Apply the lens cleaner generously to dissolve the grease.
 2. Blot off the lens cleaner and dissolved grease using minimum motion.
Avoid rubbing the lens, since hard particles from the deposit or the lens cloth can

scratch the optical coatings.

- If the greasy deposits do not come off with the lens cleaner, use a lens cloth with a stronger solvent such as reagent-grade acetone as a last resort.
 1. Gently wipe the lens surface while continually changing the section of cloth so that a clean cloth is always used on the surface of the lens.
 2. Wipe in a circular manner moving from the center of the lens to the outer edge.
 3. Do not reuse the lens cloth to avoid redepositing contaminants.

8.6.3 Cleaning Mechanical Parts

To ensure a long, trouble-free service life, wipe down the system regularly to remove any dust or dirt from the system. Most critical components are covered and require no user service. Should the stage mechanics require service, contact your Starrett representative.

8.7 Applying Lubrication

Caution

Use only approved lubricants, as inappropriate lubricants can damage system components. Approved lubricants may be obtained by contacting Starrett or an authorized Starrett representative.

Every 6 months, lead screws can be lubricated with a small amount of lead screw lubricant (Starrett part number 7946). Apply to each screw and traverse the stage or column through the entire range of travel several times to distribute the lubricant. Use a clean, soft cloth or paper towel to wipe up any excess.

8.8 Accessing Components within the System

The main housing of the HDV500 system contains the system's electronics, which include the system's computer, M3 controller interface, and CNC amplifiers for the X, Y and Z axes. There are no user-serviceable components inside, and operators will normally never have to open the housing. However, service personnel might need to open the housing to troubleshoot, replace or upgrade system components.

The electronics can be accessed by opening the two doors on the right and left sides of the housing. Refer to the following figure. The doors are held closed by three magnets at the front of the housing, as shown in Figure 32.



Figure 32. HDV500 Doors in the Closed Position

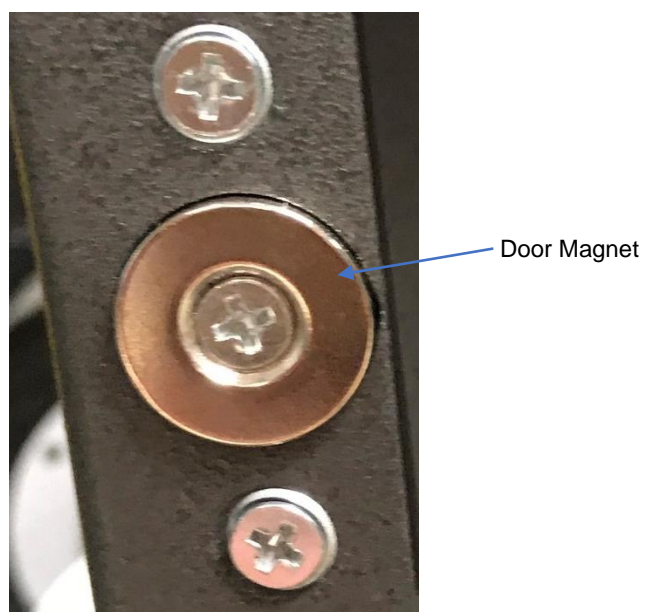


Figure 33. Door Magnet

To open a door, refer to the following figures and perform the following steps:

1. Engage the door retention device at the rear of the system by moving it upward.
2. Open door and push it toward the rear of system until the magnetic on the retention device engages.



Figure 34. Closed Door with Retention Device Engaged (Upward Position)



Figure 35. Magnetized Door Retention Device



Figure 36. HDV System with Door Open

To close the door, performing the following steps:

1. Push the door away from the retention device disengaging the magnet.
2. Continue to push the door toward the front of the system until the magnet on the front of the system engages.
3. Push the retention device downward to the original position.

8.9 Spare Parts and Accessories

The following tables provide the spare parts and the available accessories for the HDV systems. Contact your SKE Technical Services Representative or visit www.starrettmetrology.com to order parts and accessories.

Spare Parts

Description	Part Number
Fan filter 120-millimeter (4-3/4 inch)	Available from electronics distributors and computer stores
5 Amp time delay fuse	5595

Accessories

Item	Description	Part Number
Detachable Lockout device	Control unexpected hazardous energy going to the socket.	148081 (Brady brand)
Padlock Kit	Kit includes a compact nylon padlock, a lockout tag, and a cable tie. The kit is used in conjunction with the lockout device.	150938 (SafeKey brand)
Combination FOV and magnification checker calibration standard	NIST traceable 4 x 7-inch calibration standard for pixel calibration and verification.	9123
500 mm x 200 mm calibration grid	NIST-traceable 500 x 200 millimeter calibration grid including protective storage case and certificate.	6857-1

9 Glossary

The following terms might have additional meanings. The definitions that follow are in the context of the HDV500 horizontal digital video system.

A

accuracy

The maximum error that the system will produce when measuring a true standard.

ampere (amp)

The base unit of electric current in the International System of Units (SI).

aperture

An optical element which limits the diameter of the optical bundle that can pass through a specific plane.

arc second

A unit of measurement that describes the magnitude of an angle. It is typically used for small angles that cannot be practically described using degrees as a unit of measurement and is 1/60th of an arc minute.

axis

A direction which allows movement and along which dimensions can be measured. In the HDV500, the X-axis is horizontal from left to right, and the Y axis is vertical from bottom to top.

axial runout

The error between an item and the central axis caused as a result of the rotating component not being parallel. In other words, an angular error in the component will contribute to greater axial runout.

B

blooming

A condition where the parts of the video image are distorted by oversaturated bright regions, making objects appear larger than they really are.

C

CAD file

See Computer-Aided Design.

CCD

See charge coupled device.

charge coupled device (CCD)

The solid-state image sensing element of the video camera.

CNC

See computer numerical control.

Computer-Aided Design file (CAD)

The .cad file extension is used for a 3D graphics file format, which is often associated with CAD (computer aided design) projects. These .cad files contain digital 2D and 3D graphics.

computer numerical control (CNC)

The automated control of machining tools by means of a computer. A CNC machine processes a piece of material (metal, plastic, wood, ceramic, or composite) to meet specifications by following a coded programmed instruction and without a manual operator.

contour illumination

An illumination method to measure the workpiece by transmitted light and different lenses, used mainly for measuring magnified contour image of a component.

D

datum

An idealized reference feature from which another features' orientation, position, or other characteristic is defined. Datums can be many types of features, planes, cylinders, points, centerlines, constructions or offsets from other features, anything that can be measured or established for use in locating other features.

distortion

Image distortion across the field of view. Expressed in percent for the dimensional error along one axis divided by the true dimension. Resulting measurement errors can be almost eliminated by software compensation.

Drawing Exchange Format (DXF)

A computer aided design (CAD) data file format developed by Autodesk, Inc. and now also used by other companies for the export and import of CAD data.

DXF

See Drawing Exchange Format.

E

electromagnetic interface (EMI)

Also called radio-frequency interference (RFI) when in the radio frequency spectrum, is a disturbance generated by an external source that affects an electrical circuit by electromagnetic induction, electrostatic coupling, or conduction.

See *also*, radio-frequency interface (RFI).

EMI

See Electromagnetic interference (EMI).

F

fiducial

An object placed in the field of view of an imaging system that appears in the image produced, for use as a point of reference or a measure. It may be either something placed into or on the imaging subject, or a mark or set of marks in the reticle of an optical instrument.

Field of View (FOV)

The region of the metrology stage being viewed by the camera and displayed on the video monitor.

Field of View (FOV) Measurement

A video measurement performed in a single field of view without moving the stage or camera.

focus

The condition which provides the sharpest image. Achieved by optimizing the distance between the object and imaging optics.

FOV

See Field of View.

I

Illumination

The energy of light (ϵ) striking a surface of specific unit area per unit time.

L

LED

See light emitting diode.

light emitting diode (LED)

A semiconductor diode that emits light when a voltage is applied to it and that is used especially in electronic devices (as for an indicator light).

linear standard scale

In metrology, precision glass scales used for checking magnification accuracy of comparators.

line pairs / mm

The finest spacing of line pairs that can be visually resolved for standardized patterns of alternating black and white lines. In a vision metrology system, this measure reflects camera resolution, monitor resolution, and the performance of the optics.

M

magnification (mag)

The apparent enlargement of an object by an optical instrument. Abbreviated mag.

magnification checker

A tool to assist machine vision users in qualifying the pixel size of any camera type.

magnification, image

Image size on the video monitor divided by the corresponding object size. Same as lens magnification in a properly adjusted optical comparator.

magnification, lens

In a vision metrology system, the image size in the sensor plane divided by the corresponding object size (0.24X, 0.16X, 0.11X for HDV500 telecentric lenses). In an optical comparator, the image size on the projection screen divided by the corresponding object size (typically 10X to 100X).

MetLogix M3 Software

Advanced metrology software for performing two and three axis measurements in encoder-based systems and field of view systems at high levels of precision and accuracy. M3 software is included with HDV systems.

micron (μm)

A unit in the metric system equal to one millionth of a meter or approximately 0.00003937 inches. It is commonly used to describe the uncertainty of precision measuring machines.

N

National Institute of Standards and Technology (NIST)

A physical sciences laboratory and a non-regulatory agency of the United States Department of Commerce. Its mission is to promote innovation and industrial competitiveness. NIST's activities are organized into laboratory programs that include nanoscale science and technology, engineering, information technology, neutron research, material measurement, and physical measurement.

newton (N)

The International System of Units (SI) derived unit of force. A newton is defined as the force required to accelerate an object with a mass of 1 kilogram 1 meter per second per second ($1 \text{ kg} \cdot \text{m/s}^2$).

NIST

See National Institute of Standards and Technology.

P

pixel

A picture element. Term used to describe the individual light detectors of the sensor in the camera and also the individual light emitters of an LCD video monitor.

profile light

Lighting applied from the back of the object so as to create a silhouette or contour when the object is viewed by the camera.

R

radio-frequency interface (RFI)

The radiation or conduction of radio frequency energy (or electronic noise) produced by electrical and electronic devices at levels that interfere with the operation of adjacent equipment.

See *also*, electromagnetic interface (EMI).

repeatability

The three-sigma variation of multiple readings on the same object that is positioned at multiple locations across the field of view.

RFI

See radio-frequency interface.

resolution

The least significant digit to which a physical quantity can be read. High resolution does not imply high accuracy.

S

skew

Misalignment of the part with respect to the X and Y axes. This misalignment creates measurement errors unless the part is repositioned or the de-skew feature of the metrology software redefines the measurement axes.

surface illumination

An illumination method that provides an image of enhanced contrast, and minimum illumination to view the component clearly.

surface light

Lighting applied to the object from the same side as the camera so that surface features can be viewed on the video monitor.

squareness

The alignment of the camera relative to the motion of the metrology stage. If the camera is misaligned (out of square), the image will drift diagonally as the stage position is moved along one axis.

standard

In metrology, an object that has a defined relationship to a unit of measurement of a physical quantity. Standards are the fundamental reference for a system of weights and measures, against which all other measuring devices are compared.

See also linear standard scale.

stitching

The ability to perform accurate measurements by moving the stage to combine (or stitch together) multiple fields of view.

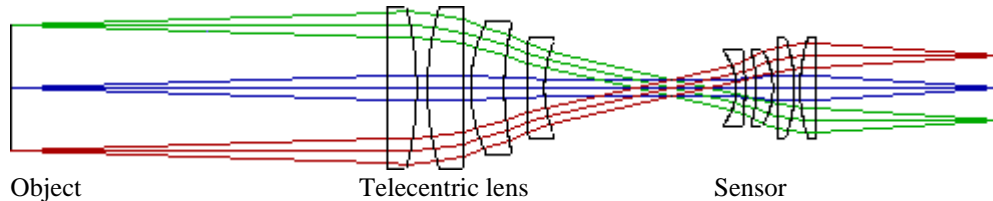
system PC

A space saving personal computer where all electronics, disk drives and I/O connections are in the same enclosure. Also referred to as a small form factor PC.

T

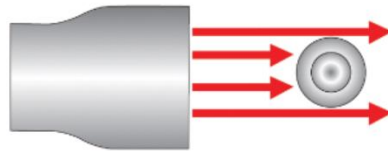
telecentric

A lens property where the light from the object stays parallel to the optical axis across the entire field of view, thereby eliminating optical distortion. This can only happen if the entrance aperture of the lens is larger than the field of view, requiring a large and expensive lens.



telecentric illumination

Using optics to direct light from an LED onto an object under inspection, producing a high contrast silhouette. Telecentric illumination increases edge contrast and measurement accuracy by decreasing diffuse reflections from the object. See the following figure.



V

VED

See video edge detection.

video edge detection (VED)

A system where a video camera and digital image processing are used to detect edges or other features.

