HDV500

Floor Mounted Horizontal Digital Video Comparator User Manual

Starrett Kinemetric Engineering

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1. PREFACE

1.1 Welcome

Thank you for purchasing an HDV500 Floor Mounted Horizontal Digital Video Comparator. We are pleased that your search has led you to Starrett Kinemetric Engineering, a subsidiary of the L.S. Starrett Company. This manual is intended to maximize your satisfaction with your system and ensure the best operating performance. Please feel free to contact Starrett Kinemetric at any time. We value your feedback and your satisfaction as a customer.

1.2 Safety Symbols & Terminology

The following symbols and terms are used in this manual to call attention to important safety issues. Heed these notices carefully in order to avoid personal injury or damage to the system.

Symbol or Term	Meaning
	**CAUTION:** Failure to heed this message may result in personal injury or equipment damage.
	**WARNING:** Dangerous voltage. Risk of electrical shock. Failure to observe this warning may result in equipment damage, personal injury or death.
	**WARNING:** Disconnect equipment from power source. Failure to observe this warning may result in equipment damage, personal injury or death.
	**CAUTION:** Pinch Point - Keep hands clear. Failure to observe this warning may result in personal injury or equipment damage.
DANGER	Immediate hazard which could result in severe personal injury.
WARNING	Hazard or unsafe practice which could result in personal injury.
CAUTION	Hazard or unsafe practice which could result in equipment damage or injury.
NOTE	Information that is helpful in properly operating the equipment.

1.3 Warranty

Starrett Kinemetric products carry a one-year (from date of purchase) warranty against defects in material and workmanship (parts and labor), subject to factory inspection. The L.S. Starrett Company will repair or replace, at its option, any part or parts found to be defective in workmanship or material. Starrett warrants repaired or replaced parts for the balance of the original warranty period or 90 days, whichever is longer. Parts returned to the factory under warranty will be repaired at no charge. Freight charges to the factory will be paid by the customer. Return freight charges to the customer will be paid by Starrett.

This warranty does not cover damages from such causes as abuse, accident, neglect, fire or freight damage. It does not apply to defects resulting from modifications made by the customer or improper use of the system or its components.

1.4 Regulatory Compliance

CE 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. As of November 2015, testing by an independent test lab remained to be done. HDV500 systems are certified by Starrett to be free from hazardous materials per 2002/ 95/EC RoHS.

EMC Standards

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

Safety Standards

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

1.5 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.

1.6 Copyright & Trademark Information

2. HDV500 DESCRIPTION

The HDV500 is a large horizontal digital video comparator which combines the best features of a vision metrology system and a floor-mounted horizontal optical comparator. Key features include 500 mm (20”) of stage travel, 150 kg (330 lb) load capacity, and a large 1067 mm (42”) diagonal video monitor. The system comes with a 5-megapixel digital video camera and 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 for accurate field-of-view (FOV) measurements. The telecentric lenses are mounted by means of a bayonet fitting and can be changed by the user in a matter of seconds.

The HDV500 is 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 joy-stick. The system comes with 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. 2D geometric functions include points, lines, circles, arcs, rectangles, distances, slots, angles and skew. The software will also stitch multiple images so that field-of-view measurements are seamlessly integrated with stage motion to measure large parts.

HDV systems are rugged machines that are equally at home in a quality lab or on the shop floor. The housing is made of welded steel, like a Starrett comparator. 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 kg (360 lbs). Linear glass scales provide 0.5 µm (0.00002”) of resolution to read stage motion. The computer and M3 controller 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.

The main operator interface is a 42” video monitor, which displays a live video image of the part in addition to geometry tools and digital readings. The image of the part can be resized in software using pan and zoom, and measurements are taken by invoking any of many available computer tools. An environmentally sealed keyboard with an integral touchpad is part of the system.

2.1 Telecentric Lens Options

The HDV500 base system comes with a bayonet mount which allows telecentric optics to be changed by the user in seconds. Three telecentric lenses are available with rated optical magnifications of 0.24X, 0.16X and 0.11X, which provide fields of view of 36 mm, 52 mm and 76 mm.

2.2 HDV System Features & Performance

Disclaimer: Due to continual product improvements, specifications may change without notice.

Caution: Exceeding the maximum load capacity of 150 kg (330 lbs) will significantly reduce accuracies of your system and may damage the mechanical structure.

1. **Performance**

Feature	Specification
Stage Travel, X (left-right)	500 mm (20”)
Stage Travel, Y (up-down)	200 mm (8”)
Focus Range, Z (front-back)	75 mm (3.0”)
Maximum Object Height	250 mm (10”)
Scale Resolution, X & Y	0.5 µm (0.00002”)
Reading Accuracy, X & Y	E1 = 3.0 µm + 1 µm x L/(33 mm)
Stage Load Capacity	20 kg (44 lbs) for negligible deflection, 100 kg (220 lbs) 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

2. **Mechanical**

Feature	Specification
Mounting Location	Floor mount
Height to Top of Monitor	1800 mm (70.7”) (max)
Height to Center of Monitor	1460 mm (57.5”) typ, ± 90 mm (3.5”) adjustment range.
Width	1330 mm (52.5”) (at extremes of stage travel)
Depth	1345 mm (53”)
Monitor Dimensions	565 x 975 x 64 mm (22.3” x 38.4” x 2.5”)
Height of Center of Monitor	0 to 250 mm (0 to 10”), adjustable
Stage Material	Steel, machines, nickel plated
Housing Material	Steel, welded, powder coated
Stage Area	820 x 200 mm (31.3” x 7.9”)
Shipping Weight	770 kg (1700 lbs), approx.

3. **Illumination**

Feature	Specification
Surface Illumination	190 mm (7.5”) diameter LED ring light mounted around body of lens
Contour Illumination	112 mm (4.5”) collimated LED backlight

4. **Optical**

Feature	Specification
Operator Display	1067 mm (42”) diagonal monitor, backlit LED, 1920 x 1080 pixels
Monitor Display Area	930 x 523 mm (36.6” x 20.6”)
Monitor Pixel Size	0.36 x 0.36 mm (0.014”)
Camera Type	Sentech STC-SC500POE, 5 megapixels (2448 x 2058) on 2/3” 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")	53.8 x 45 mm (2.1" x 1.7")	76.5x 64 mm (3.0" x 2.5")
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 (ΔH/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")	37 mm (1.46")	52 mm (2.05")
Telecentric Lens FWD	150 mm (9.0")	159 mm (6.3")	228 mm (9.0")

5. Operator Controls

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

6. Electrical

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

7. Computer & Software

Feature	Specification
Form Factor	Board level computer housed inside comparator enclosure
Computer Hardware	64-bit CPU, 500 GByte min hard disk
Network Interfaces	Externally accessible Ethernet port, 3 USB 2.0 ports
Operating System	Windows® 7 Professional
Metrology Software	MetLogix M3 Version 2 software with FOV/DXF option pack
Key Software Capabilities	CNC control, video edge detection, 2D geometrical constructs, image stitching with "superimage" measurements, comparison of live image to imported DXF image, image display with error whiskers, advanced report generation, pivot mode to display selected results across multiple runs.

8. Environmental

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

3. HDV500 SYSTEM COMPONENTS

3.1 System Components

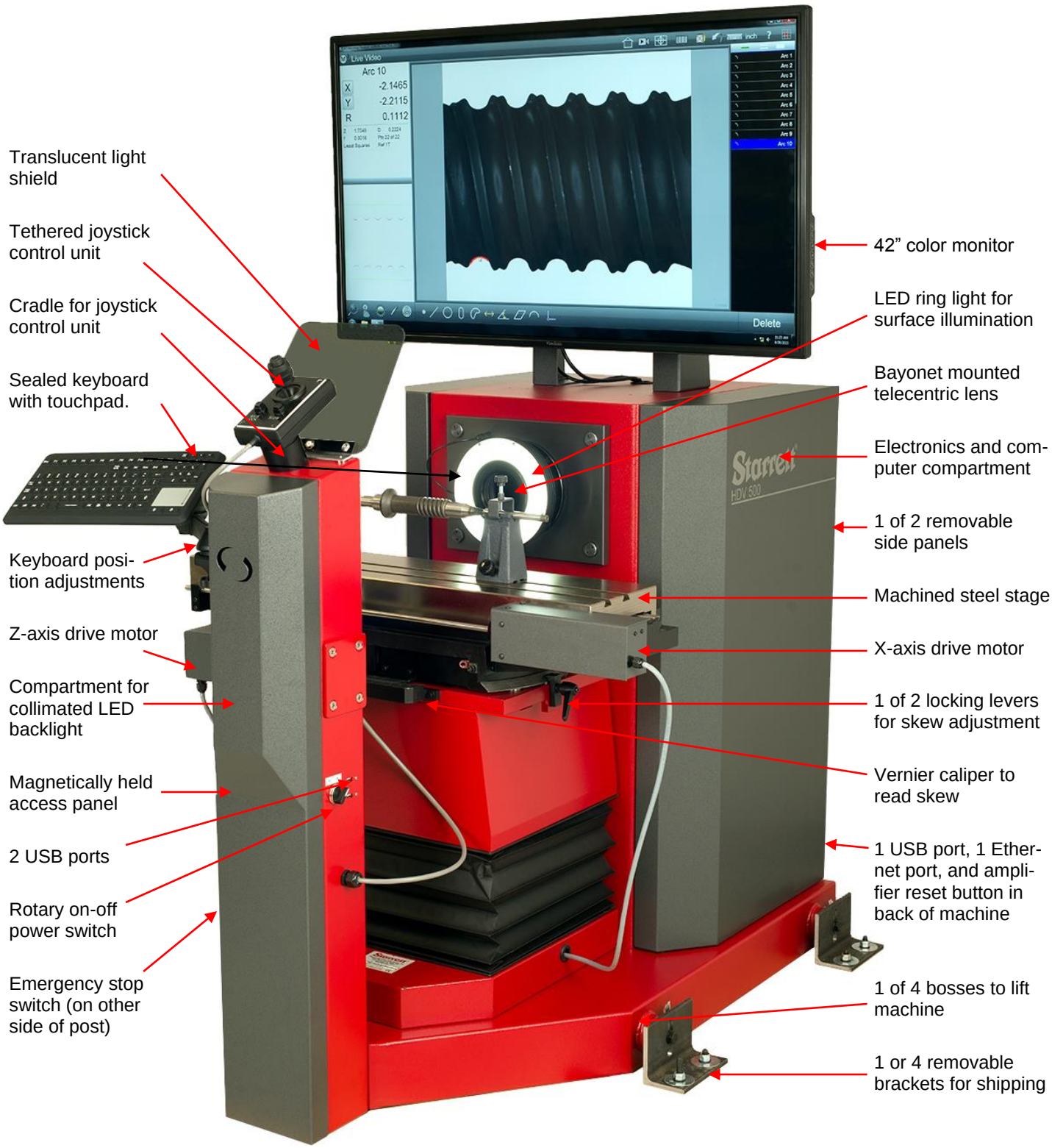


Figure 1. System component overview

3.2 Manual Illumination and Position Controls

The HDV500 allows fully automatic operation under program control for illumination, for right-left position of the stage (X-axis), for up-down position of the stage (Y-axis), and for 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 can be via sliders on the computer screen using M3 software.
- Manual control of the X, Y and Z axes can also use M3 software, which gets its inputs from the joystick unit described below.

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

	**Caution:** Be carefully not to knock the joystick unit to the floor, as it can break.

Emergency Stop switch
Press to stop all CNC motion.

Five pushbuttons:

- **Button 1 =** Speed Toggle. Located on at top of joystick. Press for slow speed for fine control. Press again for normal speed.
- **Button 2** = Axis Lock. Press for motion along one axis only. Press again to allow diagonal motion.
- **Button 3** = Z-Toggle / Q-Axis. Press for Z-axis focus control by trackball. Press again for Z-axis focus control or Q-Axis rotary stage control by trackball.
- **Button 4** = Go To Here. Press to lock in coordinates when programming.
- **Button 5** = Enter. Same as Enter key on PC keyboard.

Joystick:

- **Deflect right to left** to move stage from right to left (X-axis control).
- **Deflect front to back** to move stage up or down (Y-axis control),
- **Rotate** to move stage in and out (Z-axis focus control).

Trackball
Rotate for fine tuning X and Y positions, or for fine tuning Z-axis focus or Q-axis rotation, as set by Button 3.

Figure 2. Manual operator control unit

3.3 Keyboard Usage and Adjustment

The HDV500 keyboard is environmentally sealed. It is used for programming, data entry, and program operation. It includes and integral touchpad, which serves the functions of a mouse. Two keys below the touchpad serve the functions of the left and right mouse buttons. Note that the functions of the Enter key can be duplicated by the button at the top of the joystick, as defined in M3 software.

The articulated arm that holds the keyboard provides adjustments for position, left-to-right angle, and up-down tilt angle. Adjust the keyboard 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.

Figure 3. Sealed keyboard.

Figure 4. Attachment and adjustment of keyboard.

3.4 Changing Lenses

Figure 5. Three HDV500 telecentric lenses

Figure 6. Removal and reinstallation of ring light.

Figure 7. Removal and reinstallation of telecentric lens.

HDV500 systems are available with three telecentric lenses: 1) 0.24X magnification with a 35 x 29 mm (1.4” x 1.1”) field of view, 2) 0.16X with a 54 x 45 mm (2.1” x 1.8”) field of view, and 3) 76 x 64 mm (3.0” x 2.5” field if view. 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. Or work at higher magnification, in which case M3 software will seamlessly combine FOV measurements with encoder readings from stage motion.

To remove an installed lens, first remove the LED ring light that is attached to the lens. To do so, untighten the black knurled nut that holds the electrical cable connector to the main unit, then pull out the cable connector. Use a 2.5 mm M3 Allen wrench to loosen the clamp that secures the ring light to the lens, then pull off the ring light and set it aside. With the ring light removed, use both hands to turn the lens a few degrees to clockwise, pull it out from its bayonet fitting, and set it aside.

To install a different lens, revert this process. Insert the new lens and turn it counterclockwise by a few degrees to set it into its bayonet fitting. Reposition the ring around the lens and tighten the clamp with the same 2.5 mm M3 Allen wrench. Then reconnect the ring light electrically. Note that the black cable connector is keyed so that the two connector pins can only be inserted in one orientation.

Cautions 	• Do not leave the camera unprotected by a lens assembly to minimize dust settling on the CCD sensor surface. • Do not touch optical surfaces, since oil from your hands can permanently damage optical coatings. • Handle the lenses with extreme care, since they are breakable and very expensive. • Place unused lens assemblies in a sealed bag or enclosure for dirt protection. • Store unused lenses in a safe place where they will protected from breakage.

3.5 Environmental Considerations

HDV500 systems are factory calibrated under the standard laboratory environmental conditions shown below:

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

If the system is to be operated under environmental conditions that are substantially different from those shown above, 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 may be required when measuring parts under conditions different from those controlling the stated dimensional specifications for these parts.

3.6 Safety Considerations

General Safety 	Starrett vision metrology systems are designed for safety and proper ergonomics during normal use. Exercise caution when lifting, handling or moving the system to maintain equipment calibration and measurement performance. Consult Starrett if you have any question regarding transporting, using, or maintaining this system. 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.
Electrical Safety 	Follow the guidelines below to avoid potentially hazardous electrical conditions, which could result in electrical shock and equipment damage. • Use only properly grounded 3-prong polarized 120 Vac power receptacles in North America, or appropriate safety-rated receptacles outside of North America. • Disconnect all power sources prior to moving or working on the equipment. • Keep component air vents clear, clean and free from dust and debris to provide proper circulation to electrical components and to avoid overheating. • Keep all liquids away from the system. • Ensure that the ground is clean, dry and free from debris at all times. • Do not operate the equipment in excessively humid conditions (> 90% relative humidity). • Do not operate the equipment in an explosive environment, such as around volatile or flammable solvents. • Do not open the housing except to make computer connections or to change the fan. • Do operate system with the housing open.
	Disconnect power, or do not plug in the power cord, if hazardous conditions exist such as: • Damaged or frayed power cord. • Damaged or improperly grounded power receptacle. • Equipment exposed to excessive moisture or liquid spills. • Impact or damage to the equipment. Have the system inspected by authorized personnel before operating. • Ongoing repair service by a technician
Mechanical Safety 	**CAUTION:** The metrology stage 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.

3.7 Equipment On/Off Control

Figure 8. Power control at front of unit

Figure 9. Power entry module at rear of unit.

HDV500 systems have a rocker switch in the back of the unit adjacent to the 115/ 230V power connector as required by for CE certification, and an On/Off rotary selector switch on the right side of the contour illumination post at the front the unit. These two switches are in series. For normal operation, the rocker switch should always be in the On position marked “I”. The power switch on the side of the computer monitor and E-Stop switch most also be in the On position.

To apply power and start the system, turn the rotary power switch clockwise to the position marked “ON” or “**|**”. The system’s built-in PC will self-boot and come up in Windows. Launch the MetLogix M3 software by clicking on the M3 icon.

Before removing power, first close all computer files and applications, then shut down the computer using the Windows “Shut down” button. Otherwise computer files could be corrupted by the sudden loss of power. After the computer has been properly shut down, turn the rotary power switch counterclockwise to the position marked “OFF” or “O”.

	**Turn-Off Sequence:** Before removing power, first shut down the computer in software. This will ensure that all files are properly closed.

3.8 Communication Ports

Two USB ports are located to the right of the On/Off rotary switch on the contour illumination post, as shown in Figure 8. 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 MS 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).

3.9 Amplifier Reset Button

The HDV500 system uses three CNC amplifier units to drive motion for the X, Y and Z axes. These units are located in the bottom half of the main housing. It is possible that any of these units locks up, thereby preventing motion along one axis. A first fix is to press the “Reset CNC Amplifiers” button at the rear of the system. Pressing this button momentarily removes power from the amplifiers. Releasing this button returns power to the amplifiers, causing them to reset.

Figure 10. CNC amplifier reset

3.10 Fuse Replacement

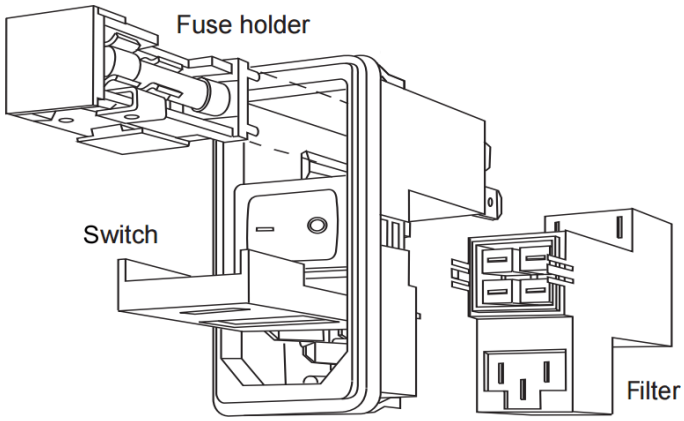


Figure 11. HDV500 power entry module

There are two fuses in an HDV500 system, both 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 may be due to a blown use. To check and replace fuses, follow these steps:

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 mm or 1/4" x 1-1/4” 5A, 250 Vac time delay fuses.
6) After replacing the fuses, press in the red fuse holder.
7) Press in the cover above the power switch.
8) Plug in the power cable.

If fuses keep blowing, there may be a more serious electrical problem, such as an electrical short. Call service.

	**Hazardous Voltages:** 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.

3.11 Access to Electronics in Main Housing

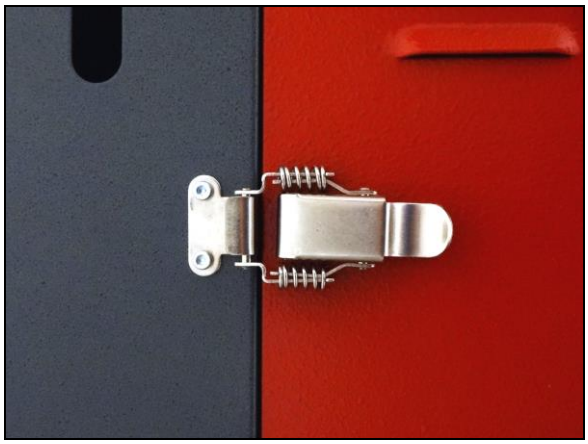


Figure 12. Spring latch for side door

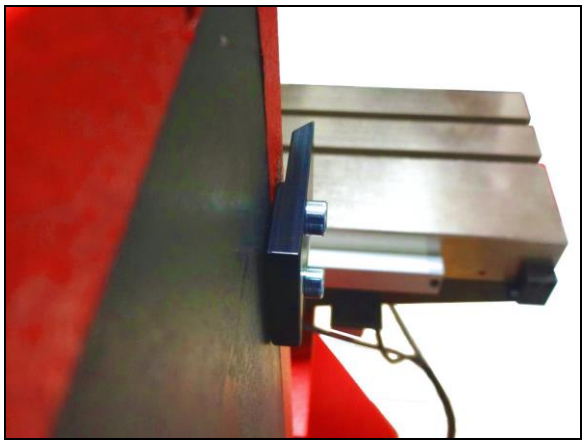


Figure 13. Front alignment tab for side door.

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 may need to open the housing to troubleshoot, replace or upgrade system components.

The electronics can be accessed by removing the two gray doors on the right and left sides of the housing. Each of these doors is held in place by two spring latches at the rear of the housing, as shown in Figure 12, and by three alignment tabs at the front of the housing, as shown in Figure 13. This attachment scheme allows the doors to be removed with minimal space to the sides of the housing.

To remove a door, open the two spring latches in the back and slide the door forward by at least 2.5 cm (1"). The door is will then clear the two alignment tabs at the front so that it can be lifted off and set aside. There is a special plastic surface at the base of each door to facilitate sliding.

To replace the door, reengage the two front alignment tabs in front, slide the door to the back to align it with the housing, and secure the two spring latches.

	**Do not swing doors outwards:** Attempting to open the doors outwards before sliding them forward and clearing the alignment tabs may bend the sheet metal of the doors or break the alignment tabs.

4. INSTALLATION

Starrett Kinemetric vision metrology systems and optical comparator systems are normally installed by a factory-trained installer who also provides operator training. The information below covers basic hardware installation in the event that such an installer is not available.

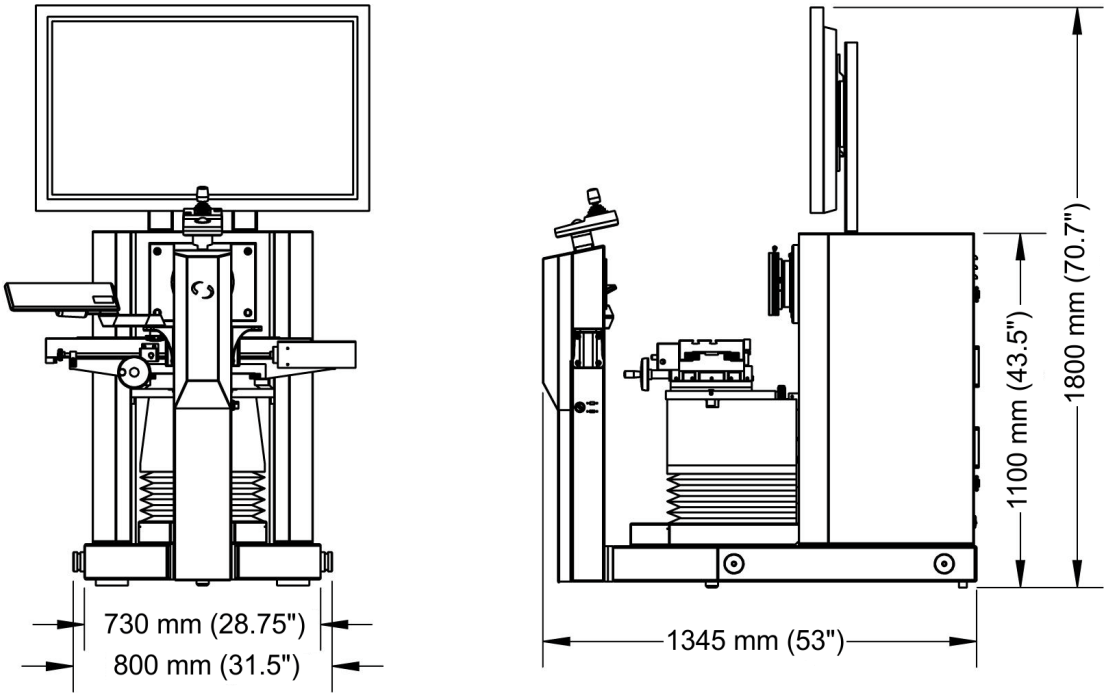


Figure 14. Dimensioned outline drawing

4.1 Selecting a Suitable Location

HDV500 systems are normally placed directly on a concrete floor in a work area. To degree possible, select a location where the temperature can be controlled to within 20°C ± 0.5°C (68°F ± 1°F), which is the calibration temperature of the system. Also select a location that is free from oil fumes, dust and debris, as contaminants will coat critical mechanical and optical parts, thereby requiring more frequent system maintenance. A grounded 2-phase electrical power outlet should be nearby.

Allow enough clearance around the machine. Allow at least 200 mm (8”) to the rear for access, and 600 mm (24”) or more to the sides. The width required for maximum X-axis stage travel is 1330 mm (52.5”). Consider the longest parts to be measured or inspected, since large parts may overhang beyond right or left sides of the stage. Also allow room for the staging of incoming and outgoing parts.

4.2 Moving the Equipment

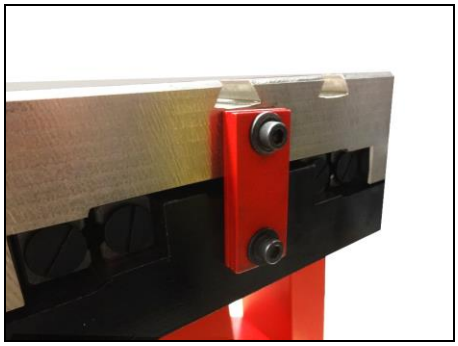
The estimated shipping weight of a crated HDV500 system is 770 kg (1700 lbs). The machine itself is too deep for the forks of most forklifts. The machine is normally moved and positioned by a professional rigger (or rigging company) with specialized skills and equipment to move and position heavy and large machinery.

4.3 Uncrating the Equipment

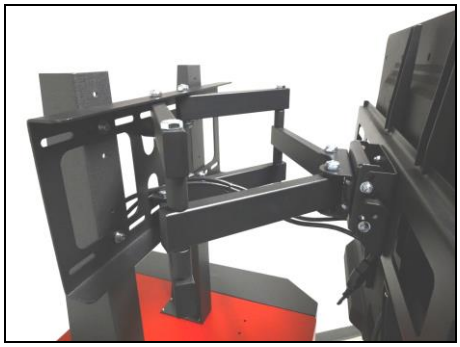
1. HDV500 systems are normally shipped in single wooden crate. Use a reversing battery powered drill with a Phillips bit to remove all wood screws from the top of the crate, then lift off the top. Remove all wood screws from the side panels of the crate, then remove the side panels. This will expose the HDV500 main unit on the shipping pallet and the 42” video monitor, which is shipped uninstalled in the same crate.

2. Use a wrench to remove the four L-shaped brackets which secure the HDV500 main unit to the shipping pallet. The main unit can now be lifted by the rigging company using the four red bosses which extend from the base.

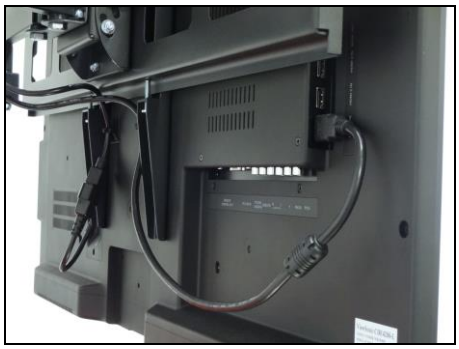
3. With the HDV500 main unit in place, remove three sets of metal shipping tabs. These are used to prevent unwanted stage motion during shipping. One set us used for the X-axis (shown), one for the Y-axis, and one for the Z-axis. Also remove any other shipping material.



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



5. Make two electrical connect to the 42” video monitor. Insert the power cable and the HDMI video cable, which should go HDMI 1 IN. Also plug in the AC power cable to at the back of the main unit.



WARNING: Make sure that the power plug to which the system is connected is a properly rated and grounded receptacle. Do not energize the power cable until the entire system has been properly set up per these instructions.

4.4 On-site Functional Test, 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 may have moved during shipment. A complete functional test and calibration are recommended following physical installation.

Professional system installation is normally provided by Starrett for all new vision metrology systems and optical comparators sold in North America. Installation includes equipment setup, on-site calibration and on-site operator training. While professional installation is a separately-quoted line item, it is highly recommended and is purchased by most users.

As part of its setup services, Starrett oversees the equipment’s in-plant transportation to its permanent location and uncrating. Starrett then performs the physical setup and electrical connection, followed by a completed functional checkout. This typically takes 1/2 day for a manual system. The system is then allowed to temperature stabilize overnight.

On-site calibration normally takes place on the day following setup. Calibration uses NIST-traceable glass grids and gage blocks. Calibration typically takes 1/2 day for a CNC system like the HDV500.

On-site basic operator training is provided following calibration. This typically takes 1 day for a CNC system like the HDV500. Many customers choose to augment basic CNC training with 1 or 2 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 limited to 1 to 3 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.

Installation 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 Kinemetric and its regional sales offices. Outside of North America, installation 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).

5. MEASUREMENT STRATEGY

5.1 Magnification Strategy

HDV500 systems can be operated with any of 3 telecentric bayonet-mounted, fixed-focus, lenses with magnification of 0.24X, 0.16X or 0.11X. 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 the smaller the field of view.

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 accommodates parts up to 76 x 64 mm (3.0 x 2.5”) in size. If the entire part cannot fit into the field of view, no problem. Simply move the stage by up to 500 mm (20”), and the M3 software will seamlessly combine FOV measurements with encoder readings from stage motion. Note that stage motion will increase the measurement time.

5.2 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.

5.3 Lighting Strategy

Once the image has been properly focused, adjust front and back lighting using the on-screen sliders provided by M3 software. You may 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 may 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 to change light levels between points used to measure the same geometrical feature.

5.4 Contour Lighting Alignment

The light source for contour illumination is in the tower at the front of the machine. It uses a tilted plane mirror to align the contour illumination with the optical axis of the lens and camera. If the mirror is tilted properly, the background illumination seen on the video screen will be even across the entire field of view.

While mirror alignment has been done at the factory, it needs to be verified following shipment and installation at the user site. It should also be verified by an authorized technician as part of periodic maintenance, but can also be performed by the user if required.

To align the mirror, first remove the gray cover at the front of the tower. This cover is held in place by 6 magnets and is aligned by 3 pins. Pull the bottom of the cover forward to remove it from the tower. With the cover removed, you will have access to adjustment screws for right and left tilt, and to a push-pull adjustment screw for up-down tilt. Using metric Allen wrenches, adjust these screws carefully until the background illumination is even. In extreme cases, you may need to access two screws for mirror rotation.

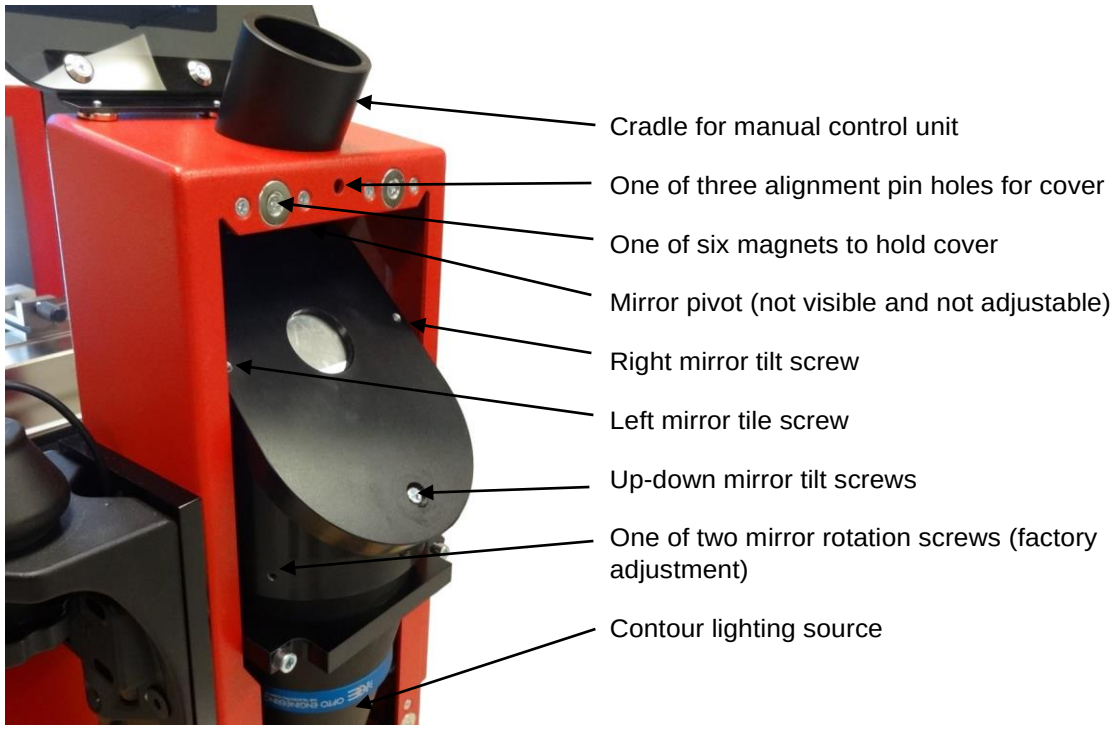


Figure 15. Contour lighting adjustments

5.5 Other Performance Factors

1. Keep the optics clean to avoid false shadows and artifacts.
2. Avoid vibration.
3. Use the calibration and shape correction algorithms available with M3 software, as described in MetLogix Tech Bulletin 080713.

5.6 M3 Software Operation

M3 software operation is outside of the scope this Starrett hardware-oriented user manual. Please refer to the separate MetLogix M3 software manual.

6. SYSTEM MAINTENANCE

HDV500 floor-standing digital video comparators 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.

- Perform a daily inspection to ensure that the system is operating correctly and that proper safety guidelines are being followed.
- Periodically verify basic optical performance.
- Periodically perform cleaning and lubrication.
- Replace the fan filter, lenses and fuses when needed.
- Schedule regular factory-authorized calibration and maintenance service to preserve proper function and accuracy.

6.1 Daily Inspections

On a daily basis, 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.

6.2 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."
- Verify that the stage control mechanisms move freely. Lubricate as needed or every 6 months, as stated later under "Lubrication."
- Check the system for calibration against a chrome-on-glass standard.

6.3 Fan Filter Maintenance

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

The fan filters should be inspected weekly for cleanliness. If ifound 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, reseat it in the bezel and press the bezel back in place. Fan filters and the fan itself are user-replaceable items. They are readily available from electronics distributors and in computer stores. When purchasing a new fan, ensure that its voltage is the same as the voltage marked on the old fan.

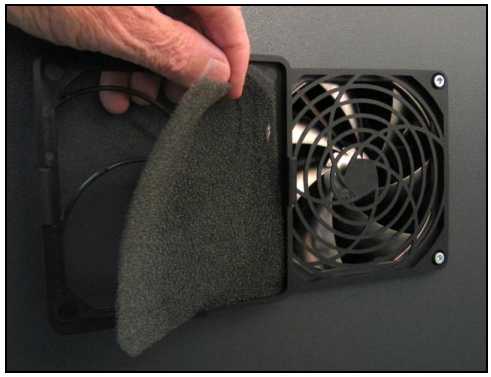


Figure 16. Replacement of fan filter.

	NOTE: Optical alignment verification may 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.

6.4 Optics Squareness

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.

Steps to check squareness:

1. Place the MAG checker or other suitable inspection part on the stage and secure properly.
2. Select the crosshair image tool in software and verify that it is at its defined center position. Please refer to the M3 software manual 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.

6.5 Calibration Verification

Calibration should be verified periodically depending on user requirements and systems usage, and should be at least monthly. Calibration should also be verified after the system has been serviced or moved. A chrome-on-glass calibration verification standard artifact, P/N 3649, is available from Starrett or its authorized distributors. This standard has a length of 300 mm and major calibration fiducials spaced every 25 mm.

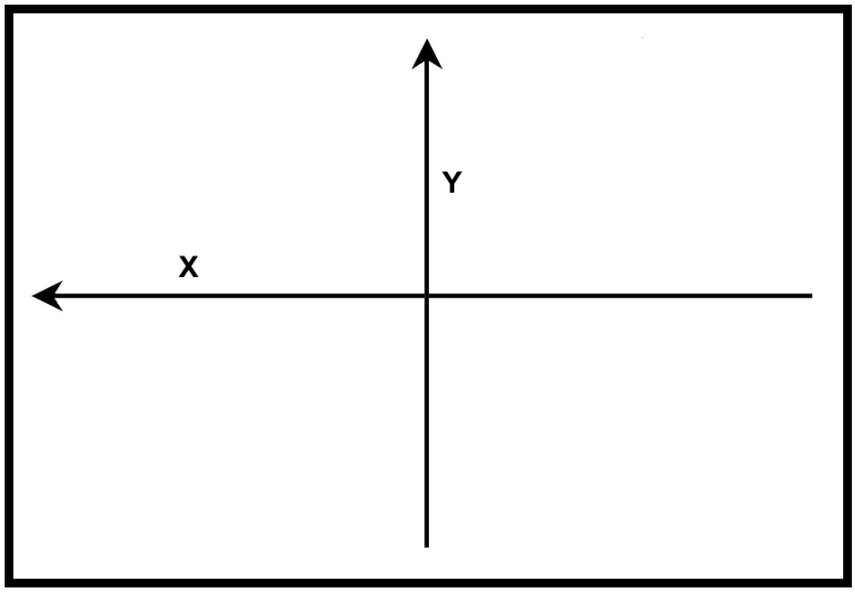


Figure 17. X and Y calibration axes

Steps to validate calibration:

1. Place the calibrated verification along the X axis. Secure the standard to the stage with a holder (available from Starrett, P/N 5755).
2. Skew the center of the two end circles of the calibration standard. Refer to the M3 software manual for proper alignment procedure.
3. Using the HDV system, measure the position of fiducials spaced every 25 mm. 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, then
5. Verify that the calculated absolute X measurement errors are within the HDV system accuracy specification, which is E1 = 3.0 µm + 1 µm x L/(33 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 ◆ is the maximum error specified by 3.0 µm + 1 µm x L/(33 mm). The green squares ■ are the absolute X errors. The red triangles ▲ are the Y errors. The HDV system is within the factory calibration spec if all X and Y errors fall below the straight line.

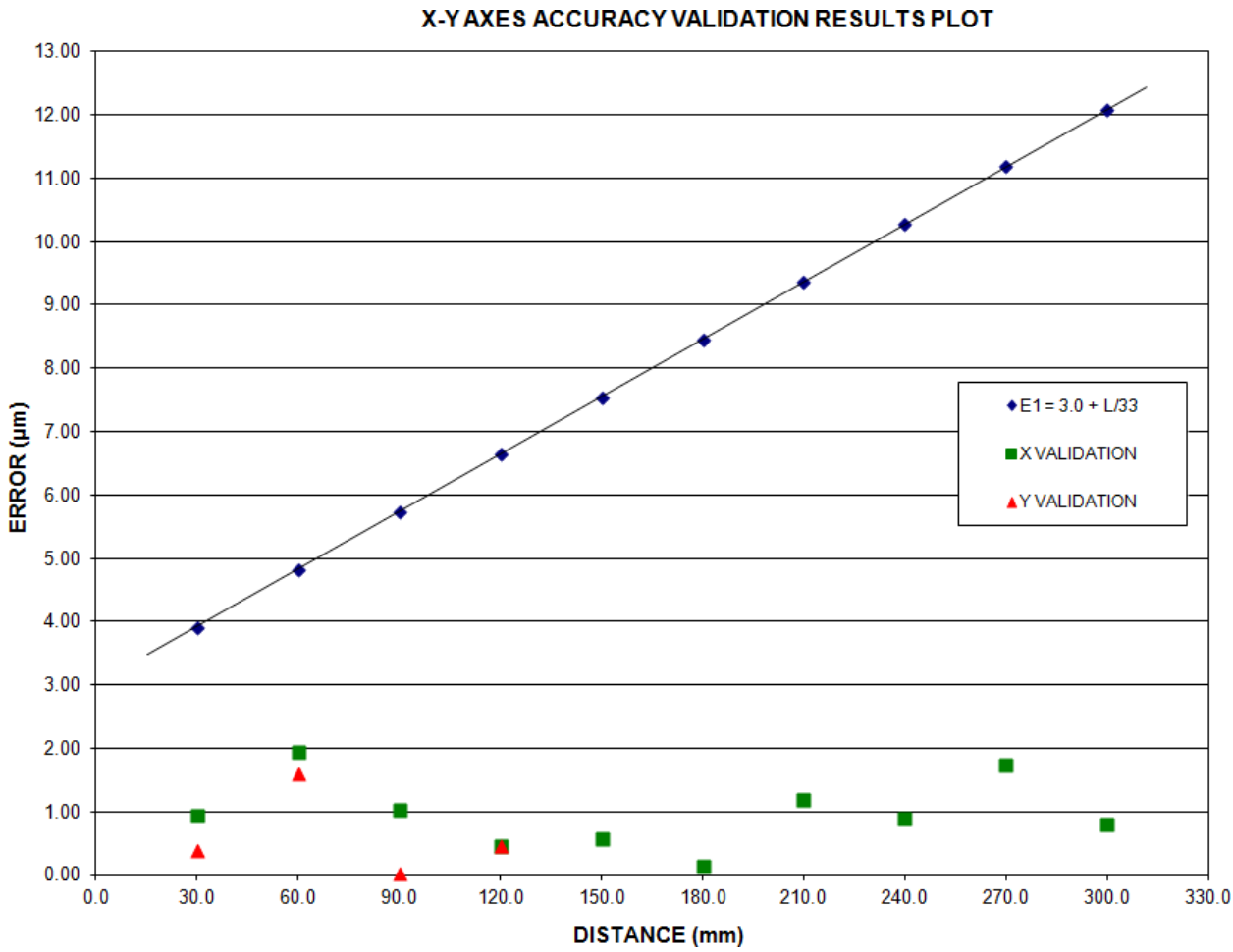


Figure 18. Sample Accuracy Validation Results Plot

6.6 Cleaning

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.

	**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, damage the equipment and possibly cause 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.

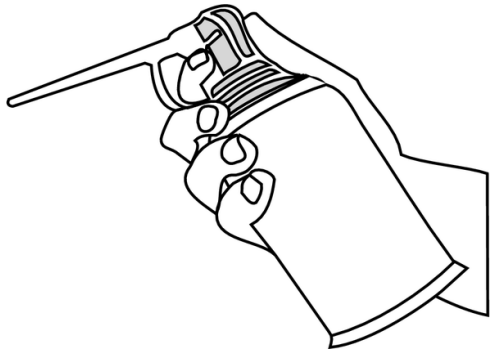
Cleaning External Surfaces

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 may damage painted or plastic surfaces. Isopropyl alcohol may be used to clean surface contaminants where Simple Green proves ineffective.

Cleaning Optics

	**WARNING:** Do not touch lens surfaces with your fingertips, since the resulting fingerprints will destroy optical coatings over time. Only clean optical surfaces with proper cleaning supplies, and then only when necessary.

If a lens is covered with loose dust, first try blowing off this dust using a can of optical grade (oil-free) canned compressed air. Be careful not to shake the lens, or propellant may blow onto the lens. As alternative, use a lens brush to gently wipe off the dust.



Optical compressed air

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. Apply the lens cleaner generously to dissolve the grease, then 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. Gently wipe the lens surface while continually changing the section of cloth used so as to always present a clean cloth surface to the lens. Wipe in a circular manner moving from the center of the lens toward the outer edge. Do not reuse the lens cloth to avoid redepositing contaminants.

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, please contact your Starrett representative.

6.7 Lubrication

Every 6 months, lead-screws may be lubricated with a small amount of Tri-Flow®. 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.

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

7. GLOSSARY

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

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

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

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.

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

CCD Charge Coupled Device. The solid-state image sensing element of the HDV500 video camera.

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.

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.

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

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

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

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

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

Line Pairs / mm The finest spacing of lines 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.

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

Mag Shorthand for magnification.

Magnification, Lens In a vision metrology system, the image size in the CCD 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).

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

Parcentricity The condition where a feature remain at the optical center of the video image throughout the magnification range of zoom optics.

Parfocality The condition where the video image remains in focus as the magnification is adjusted from highest to lowest with zoom optics.

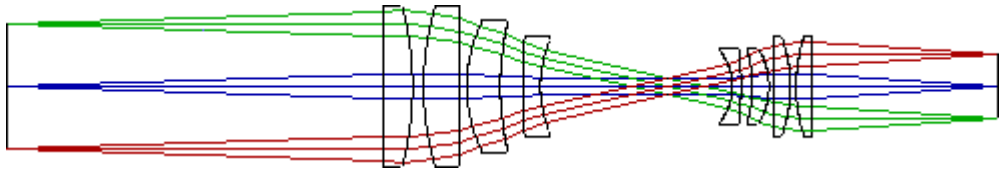
Repeatability The three-sigma variation of multiple readings on the same object that is positioned at multiple locations across the field of view.

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

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.

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

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.



Object Telecentric lens CCD detector

Zoom Optics Optics which can change magnification based on a user selection. Zoom control can be manual or motorized, depending on the metrology system.