HVR100

Benchtop Digital Video Vision System
User Manual

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1. PREFACE

1.1 Introduction

Thank you for purchasing an HVR100 Digital Video Vision System. 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 most in operating performance. Feel free to contact Starrett Kinemetric Engineering 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 to avoid personal injury or damage to the system.

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

1.3 Warranty

Starrett Kinemetric Engineering products carry a one-year warranty from date of purchase against defects in material or workmanship (parts and labor), subject to factory inspection. Starrett Kinemetric Engineering will repair or replace, at its option, any part or parts found to be defective in material or workmanship. Starrett Kinemetric Engineering 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

The HVR100 system has been inspected, tested, and evaluated by independent test laboratories and is declared to comply with Council Directives 2014/30/EU. Accordingly, these systems are entitled to bear the CE Mark. The Product Safety, EMC Testing and Evaluation reports can be provided upon request.

EMC Test Standards

Standard	Specification
EN 61326-1:2013 CISPR 11:2003+A1:2004 +A2:2006	Radiated and Conducted Emissions
EN55011 Class A	Conducted Electromagnetic Emissions
EN55011 Class A	Radiated Electromagnetic Emissions
IEC 61000-4-2:2009	Electrostatic Discharge Immunity
IEC 61000-4-5:2006	Power Line Surge Immunity
IEC 61000-4-4:2012	Electrical Fast Transients Burst Immunity
EN 61000-4-6:2009	RF Common Mode Immunity
IEC 61000-4-3:2006 +A2:2010	Radio Frequency Immunity
IEC 61000-4-8:2010	Power Frequency Magnetic Field Immunity
IEC 61000-4-11:2004	Voltage Dips and Short Interruptions Immunity

Safety Standards

Standard	Specification
EN 60204-1:2006+A1:2009	Safety of Machinery, Electrical Equipment of Machines
EN 12100	Safety of Machinery, Principles for Risk Assessment

1.5 Disclaimer of Liabilities

Starrett Kinemetric Engineering 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 and Trademark Information

2. PRODUCT DESCRIPTION

2.1 Overview

The HVR100 is a fixed-stage benchtop digital video vision system that can be oriented both vertically and horizontally. The HVR100 has a large field of view, providing optical accuracy better than .010 mm (.0004-inches)**. The system comes with a 5-megapixel digital video camera and includes a telecentric lens for micron-level resolution and measurement.

Note: ******** *Measurements were made using a 25mm fiducial on glass circle, .750-inch gauge block, and a .621-gauge pin with appropriate shape correction.*

The HVR100 is a manually operated system. The Z-axis of the telecentric lens is controlled by a wire-controlled pendant. The system features a high-strength frame, a 24-inch touch-screen monitor with a system PC, wireless keyboard, wireless mouse and MetLogix M3 vision metrology software with the M3 DXF/FOV option pack.

The M3 software includes the following features:

- Provides the ability 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 a vision system. 2D geometric functions include points, lines, circles, arcs, rectangles, distances, slots, angles and skew.
- Displays a live video image of the part plus geometry tools and digital readings. The image of the part can be resized using pan and zoom, and measurements can be taken by simply tapping a feature on the screen.

HVR100 systems are rugged machines that are equally suitable in a quality lab or on the shop floor. The maximum workload capacity of the system is 20 pounds. The computer, M3 controller, and electronics are located inside the housing, resulting in a clean design with minimal external wiring. The housing is designed to minimize the entry of oil and dust particles in machine shop environments.

Two high-speed data cables carry all signals between the metrology unit and system PC. Superb metrology performance is provided by a high-resolution video camera and telecentric lens that enable accurate field-of-view (FOV) measurements.

2.2 HVR100 Configurations

The HVR100 system can be configured in both vertical and horizontal system positions. This dual configuration provides the best features of a vision metrology system in one system. Switching from one configuration to another is accomplished quickly and easily with minimal configuration changes.

2.3 System Specifications

Performance

Feature	Specification
Focus Range, Z (front-back)	165.1 mm (6.5 inches)
Maximum Object Height	152.4 mm (6 inches)
Stage Load Capacity	20 lbs

Mechanical

Feature	Specification
Mounting Location	Benchtop
Height	1016 mm (40 inches)
Width	432 (17 inches)
Depth	432 (17 inches)
Monitor Dimensions	565 x 975 x 64 mm (24 x 38.4 x 2.5 inches)
Height of Center of Monitor	0 to 250 mm (0 to 10 inches), adjustable
Basic Stand	Billet machined frame
Stage Material	Aluminum
Housing Material	Aluminum
Stage Area	349.25 x 165.1 mm (13.75 x 6.5 inches)
Shipping Weight	206 pounds (93.4 kilograms)
Shipping container dimensions	121.9 x 66.0 x 78.7 cm (48 x 26 x 31 inches)

Illumination

Feature	Specification
Surface Illumination	190 mm (7.5 inches) diameter LED ring light mounted around body of lens
Profile Illumination	120 mm (4.7 inches) collimated LED backlight

Optical

Feature	Specification
Operator Display	609.6 mm (24 inches) diagonal monitor, backlit LED, 1920x1080 pixels
Monitor Display Area	279.4mm x 241.3 mm (11 x 9.5 inches)
Monitor Pixel Size	0.36 x 0.36 mm (0.014”)
Camera Type	Sentech monochromic, 5 megapixels (2448 x 2058) on 2/3-inch array
Camera Interface	USB 3.0 cable
Optics Mount	Fixed
Working Distance	255 mm
Telecentric Lens Magnification	.090X
Telecentric Lens Field of View	92.7 mm x 76.2 mm (3.65 x 3.0 inches)
Screen magnification	3X
Visual Resolution on Monitor	1920 x 1080 pixels
Optical Distortion	-.026%
Telecentric Depth of Field (split 1/3 front, 2/3 back)	25 mm
Telecentric Lens FWD	255 mm
Optical accuracy **	.010 mm (.0004-inches) or better

Note: ******** *Measurements were made using a 25mm fiducial on glass circle, .750-inch gauge block, and a .621-gauge pin with appropriate shape correction.*

Operator Controls

Feature	Specification
Computer Interface	24-inch color monitor, wireless keyboard and wireless mouse
Lens movement	Wire-controlled pendant that controls the speed and direction of telecentric lens moving on the Z-axis.
Power	On/Off switch that powers the HVR system on and off.

Internal Power Supply

Feature	Specification
Voltage Requirement	120/240V AC
Frequency	50-60 Hz
Maximum current	1.3A
Output	24V, 60W, 2.5A

External Power Supply

Feature	Specification
Power Supply	“Brick” type AC adapter, 100/240 VAC for the PC
Voltage Requirement	120/240V AC
Power Requirement, Main Unit	40W
Power Requirement, Monitor	60W typical

Computer & Software

Feature	Specification
Computer Hardware	System PC
Network Interfaces	Ethernet (1 GB/sec), Wi-Fi, 6 USB 2.0 ports, 2 USB 3.0 ports
Operating System	Windows® 10 Professional
Application Software	MetLogix M3 Version 2 software with FOV/DXF option pack
Comparison to CAD files	DXF CAD file import, automatic comparison to CAD files
Geometrical Constructs	2D geometries
Operator Controls	Computer touch-screen, wireless keyboard, wireless optical mouse

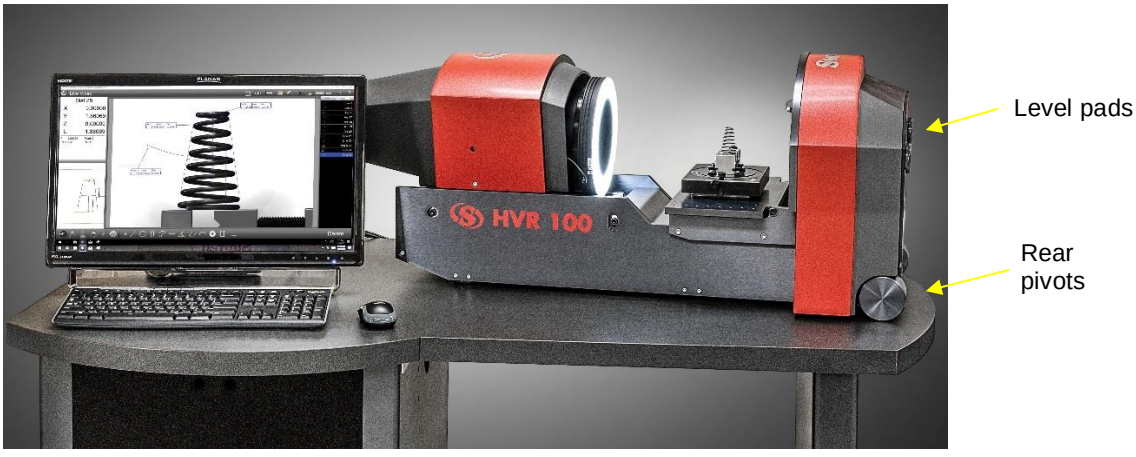
Applications

Feature	Specification
Video Inspection	Yes
Dimensioning	Video edge detection (VED)
Geometric Constructs	Yes
Image Annotation	Yes
Image Archiving	Yes

3. HVR100 SYSTEM COMPONENTS

The following figures illustrate the key components of the HVR100 system.

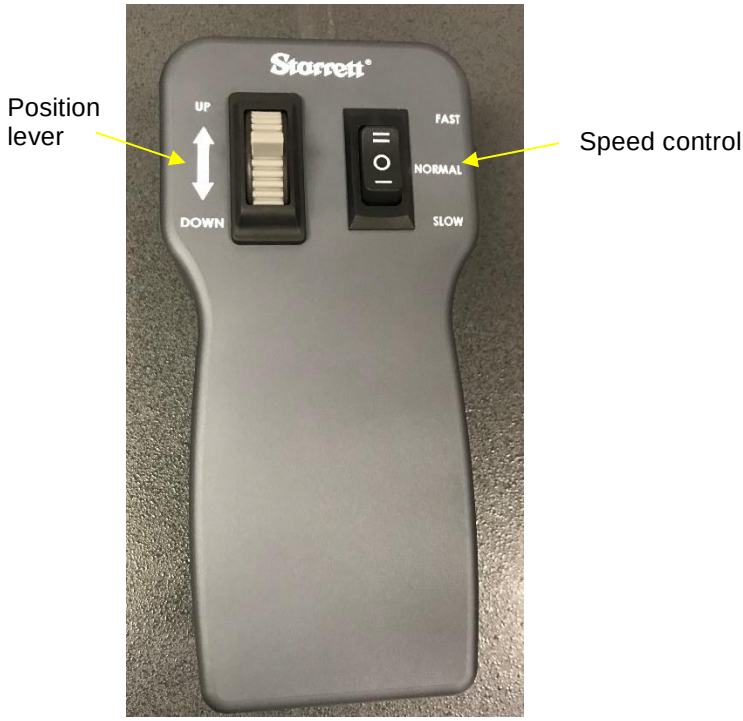
HVR100 System Components (Vertical Position)



HVR100 System Components (Horizontal Position)

3.1 Manual Illumination and Lens Control

The focus position of the telecentric lens is controlled by a wire-controlled pendant. The pendant is connected to the I/O control panel on the right side of the system with a DB9 connector. The pendant includes functionality to control both speed and position of the lens. See the figure below.



Wire-Controlled Pendant

Control	Function Tasks
Speed selector	• Move the selector up (=) to set the speed to Fast. • Move the selector to the middle position (O) to set the speed to Normal. • Move the selector down (—) to set the speed to Slow.
Position Lever	• Push the lever to the Up position to move the lens up in the vertical direction. • Push the lever to the Down position to move the lens down in the vertical direction.

The light levels are controlled through slides within the M3 software. Refer to the M3 software documentation for additional information.

3.2 Keyboard Usage and Wireless Mouse

The HDV100 wireless keyboard is used for programming, data entry, and program operation. The system also includes a wireless mouse to control program operation.

- Power to the wireless mouse is provided by a single AA battery. Have spare AA batteries on hand.
- Power to the wireless keyboard is provided by two AAA batteries. Have spare AAA batteries on hand.

3.3 Electrical Power

HVR metrology unit includes an internal power supply. The unit accepts 100/240 VAC (50/60 Hz) power for worldwide use. The maximum combined current draw is 1.3A. Ensure that the power outlet is rated for at least these currents. The I/O panel on the unit includes a receptacle for a standard C13 power cord

The HVR system PC is powered by a “brick” type AC adapter (19.5 VDC output). The adapter accepts 100/240 VAC power for worldwide use. The maximum combined current draw is 4.6A at 120 VAC or 2.3A at 240 VAC.

The power adapter is normally placed on the floor. Before doing so, verify that the floor will not be flooded or hosed down for cleaning. If there is danger of contact with water on the floor, place the adapters in a higher, protected location.

System PC Power Supply

3.4 Operational Values

HVR100 systems are factory calibrated under the standard laboratory environmental conditions shown below:

Specification	Calibration 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

HVR100 systems can be safely operated under the following environmental conditions:

Environmental Condition	Operational Requirement
Ambient Temperature	20°C ± 3°C (68°F ± 5°F)
Humidity	< 90% RH
Calibration Temperature	20 ± 0.5°C (68 ± 1°F)
Allowable Operating Temp.	18-22°C (64-72°F), non-condensing

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 might be required when measuring parts under conditions different from those controlling the stated dimensional specifications for these parts.

3.5 Safety Considerations

System or Term	Meaning
General Safety 	HVR systems are designed for safety and proper ergonomics during normal use. Exercise caution when lifting, handling or moving the system to avoid personal injury and to maintain equipment calibration and measurement performance. Disconnect all power sources prior to moving or working on the equipment. Consult Starrett if you have any questions regarding transporting, using or maintaining this system.
Electrical Safety 	HVR systems do not contain hazardous AC line voltages, as these are contained on the input side of the system AC adapters, which are UL listed. The supplied voltages are 24 VDC to the metrology unit and 19.5 VDC to the PC. 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, follow the guidelines below: • 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 system with the housing open except for service by a factory trained technician. • Keep liquids away from the system and do not operate the equipment in excessively humid conditions, as water can cause short circuits. • Keep metal filings away from the system, as such 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. • There are no fuses or user-serviceable items in the system. The system should only be opened by a factory-trained service technician.
Mechanical Safety 	The HVR100 system weighs 106 pounds. Switching the system from the vertical to horizontal position requires two people. Do not attempt to move the system without proper assistance.

4. INSTALLATION

4.1 Installation Overview

Starrett Kinemetric Engineering Vision Metrology and Optical systems are normally installed by a factory-trained technician who also provides operator training. The following information covers basic hardware installation if an installer is not available.

Installation on the system requires the following overall steps:

- Planning placement of the system
- Moving the system
- Unpacking the system
- Setting up the system PC
- Setting up the metrology unit
- Verifying the system is operational

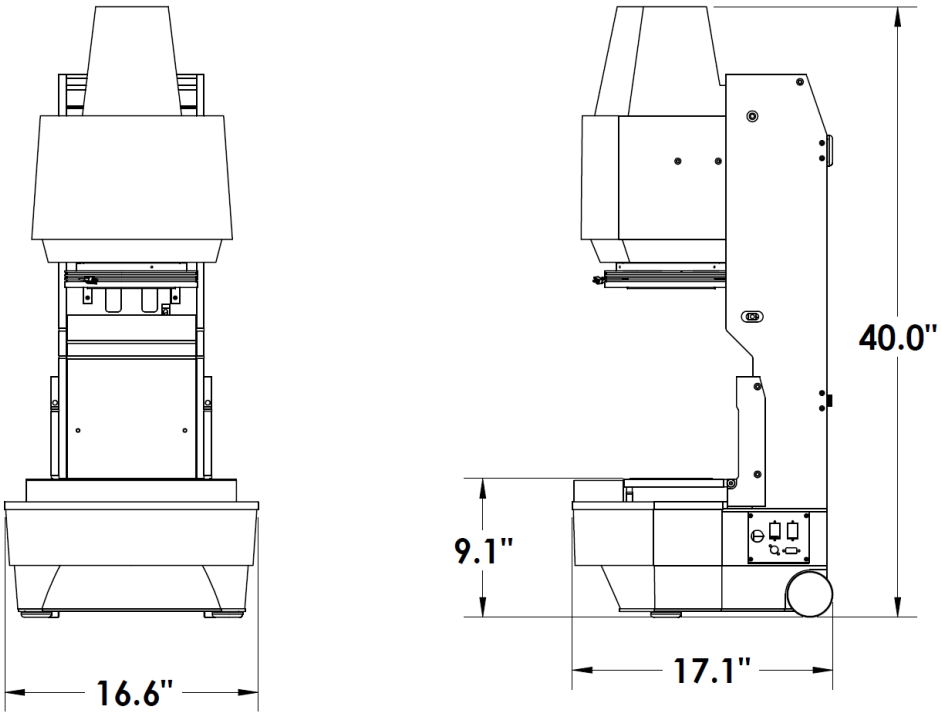
4.2 Planning Placement of the System

Prior to unpacking the system, refer to the following guidelines to ensure an adequate operating environment is established.

A clean operating environment is recommended to minimize the accumulation of dirt on the optics and on precision mechanical parts, such as lead screws and encoder scales.

HVR systems are designed to be installed on a benchtop at a height of approximately 85 cm (33.5 inches), which is the height of Starrett's ergonomic workstation. A level work surface, as checked with a bubble level, is recommended, but is not essential. Allow 60 cm (24 inches) to right or left side of the metrology unit to position the system PC. An additional clearance of 30 cm (12 inches) on both sides is recommended for general access. Allow a minimum of 5 cm (2 inches) behind the unit for air flow, as the electronics compartment only uses convective air cooling. Refer to the following figure for dimensions of the HVR100 metrology unit.

Completely opening the hinged door at the back of the metrology unit for service access requires an additional 50 cm (20 inches) of space. The metrology unit can be moved as needed for service.



HVR100 Metrology Unit Dimensions

4.3 Moving the System

HVR systems are shipped in a wooden shipping crate. Use a forklift or pallet cart to move the crate within the building to the final location where the system will be installed. Exercise care in handling the unopened shipping crate, as excessive force or a drop might damage its contents.

HVR100 Shipping Container

4.4 Unpacking the System

The HVR100 system arrives in one crate that includes all components of system including the system PC and monitor. The metrology unit arrives in the horizontal position.

Unpacking Tools

The following items are required to uncrate and install an HVR system:

- Battery powered drill with Phillips bit (to remove the top of the crate)
- Bubble level (optional, to level workbench or workstation)
- Other common hand tools

The metrology unit includes a permanent handle at the top of the unit (see the figure below) and two handles at the base of the unit. The threaded handles at the base of the unit can be removed or left on the system to facilitate possible later lifting. Specifically, the handles can be used to rotate the system from the vertical to horizontal position. See the “System with Carrying Handle Attached” figure in Section 5 of this document.

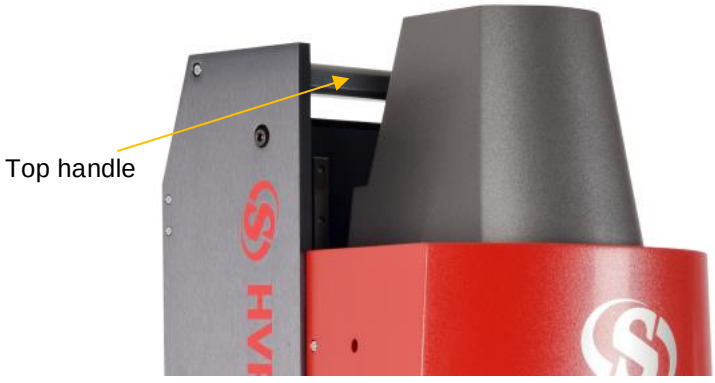
Unpacking Instructions

To unpack the system refer to the following figures and perform the following steps:

The HVR100 system weighs 106 pounds. Do not attempt to move the system without proper assistance.

1. Using a drill with a Phillips screw bit, remove the screws that attach the top of the crate.
2. With the crate now open, use the drill to remove the four woodscrews that secure the wood crossbeam holding the metrology unit in place.
3. With a person on each side of the metrology unit, use the handles to lift the unit in place.
4. Unpack the remaining components in the crate including the system PC, monitor and supporting hardware.

HVR100 System in Shipping Container



Metrology Unit Top Handle

4.5 Setting Up the System PC

Note: *This manual includes information specific to a Shuttle system PC. In some instances, the HVR system might include a system PC from another vendor.*

To set up the system PC, refer to "System Controls" figure in Section 5 and perform the following steps:

1. Connect the USB cable from the top of the system PC to the I/O panel on the HVR metrology unit.
2. Connect an additional USB cable from the top of the system PC to the I/O panel on the HVR metrology unit to support the camera signal.
3. Connect the power supply cable to the underside of the system PC.
4. Connect the monitor cable from the monitor to the underside of the system PC.
5. Ensure both the wireless keyboard and wireless mouse are equipped with batteries.
6. Press the on/off switch on the back of the mouse to turn on the mouse.
7. Press the on/off switch on the top of the keyboard to turn on the keyboard.
8. Power on the system PC. Ensure that the system PC boots up properly.
9. Verify that the preinstalled M3 software is functioning properly. Refer to the M3 software documentation for additional information.

4.6 Setting Up the Metrology Unit

To set up the metrology unit, refer to "Metrology Unit I/O Control Panel" figure in Section 5 and perform the following steps:

1. Ensure both USB cables from the system PC have been connected to the I/O panel. See "Setting Up the System PC" earlier in this section.
2. Connect the power cable to the I/O panel.
3. Connect the remaining end of the power cable to an appropriate power outlet.
4. Connect the DB9 connector for the pendant to the I/O panel.
5. Power on the unit by pressing the Power On/Off switch to the "I" position.

4.7 Verifying the System is Operational

To verify the system is operational, perform the following steps:

1. Launch the M3 software from the system PC.
2. Place a sample part on the system stage.
3. Do a single measurement on an artifact whose dimensions are comparable to those that will be measured. Verify that the measured dimensions are within the HVR's specifications.

4.8 On-site Functional Test, Calibration and Training

All Starrett vision metrology systems 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 or by an authorized Starrett dealer for all new systems 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 an HVR 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 to 1 day for an HVR system.

On-site basic operator training is provided following calibration. This typically takes 1/2 day for an HVR system. Many customers choose to augment basic training with additional 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 all users 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 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. SYSTEM OPERATIONS

5.1 System Controls

HVR100 System

On the right side of the HVR100 system is an I/O panel that includes the following controls. See the figures that follow.

Control	Function
On/Off switch	Rocker switch controls power to the system. The “I” position is On. The “O” position is Off.
Two USB 3.0 ports	• Connection from the system to PC • Connection to PC for camera signal
DB9 connector	Connection for pendant that controls the lens
Power connector	Power cable connection to a power outlet

System PC Controls

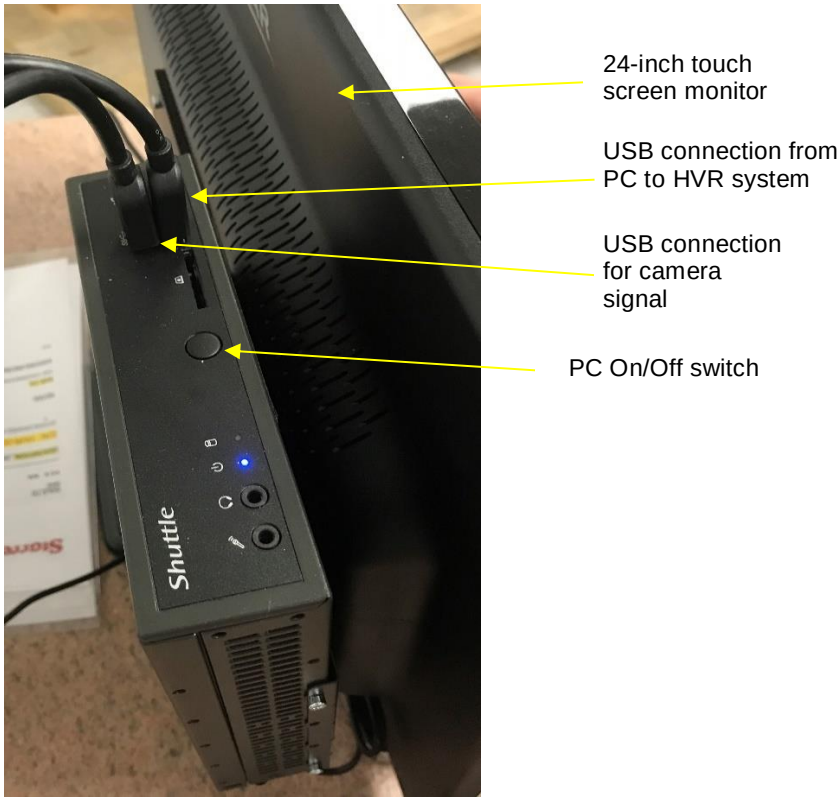
Note: *This manual includes information specific to a Shuttle system PC. In some instances, the HVR system might include a system PC from another vendor.*

The system PC includes the following controls. See the “System PC Controls” figure that follows.

Control	Function
Six USB 2.0 ports (2 on the top of the unit, 4 on the underside of the unit)	• Connection from PC to metrology unit • Connection from PC for camera signal
Two WiFi antennas	Wireless signal for connection to wireless mouse and keyboard
On/Off switch	Powers PC on and off
HDMI port	Connection to monitor
DC connector	24 VDC power input from power supply

Metrology Unit I/O Control Panel

Metrology Unit I/O Control Panel with Cable Connections



System PC Controls

Communication Ports

The communication ports on the system 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).

5.2 Powering the System On and Off

HVR systems have one On/Off switch located on the I/O panel. In addition, the system PC includes an on/off switch located on the top of the unit. Turn the system off when not in use.

	Before removing power, first close all computer files and applications, and then shut down the computer using the Windows “Shut down” button. Otherwise computer files could be corrupted by the sudden loss of power.

To power on the system, first apply power to the system PC and then to the metrology unit.

To power on the system PC, perform the following steps:

1. Ensure the system is properly cabled. Refer to the installation instructions in Section 4 of this manual.
2. Press the Power button on the top of the system PC. See the figure above.
3. Wait for the system PC to boot up completely.

To power on the metrology unit, perform the following steps:

1. Locate the On/Off rocker switch on the I/O panel. See the “Metrology Unit I/O Control Panel” figure above.
2. Press the rocker switch to the position marked “I.” “I” is the On position.

The system is now operational.

5.3 Switching the System from the Vertical to Horizontal Position

	The HVR100 system weighs 106 pounds. Switching the system from the vertical position requires two people. Do not attempt to move the system without proper assistance.

To switch the system from vertical to horizontal position, perform the following steps:

1. Ensure you have adequate space on the benchtop surface. The horizontal width of the system is 101.6 cm (40.0 inches).
2. Ensure the rear of the unit is free of all cabling.
3. Power Off the system by pressing the On/Off rocker switch to the “O” Off position.
4. With a person on each side of the system rotate the system backward using the rear pivots as a guide. You can also attach the lifting handles located near the I/O panel to help guide the system. See the figure below.
5. Ensure the system is resting on the level pads on the back of the unit.
6. Rotate the stage so that it is parallel to the ground.
7. Power On the system by pressing the On/Off rocker switch to the “I” On position.

System with Carrying Handle Attached

5.4 Switching the System from the Horizontal to Vertical Position

	The HVR100 system weighs 106 pounds. Switching the system from the horizontal position requires two people. Do not attempt to move the system without proper assistance.

To switch the system from the horizontal to vertical position, perform the following steps:

1. Ensure you have adequate space on the benchtop surface. The system is 42.16 cm (16.6 inches) wide and 43.43 cm (17.1 inches) deep.
2. Ensure the rear of the unit is free of all cabling.
3. Power Off the system by pressing the On/Off rocker switch to the “O” Off position.
4. With a person on each side of the system pull the system upward using the rear pivots as a guide.
5. Ensure the system is level with the benchtop surface.
6. Rotate the stage so that it is parallel to the ground.
7. Power On the system by pressing the On/Off rocker switch to the “I” On position.

5.5 Access to Electronics

The back of the system is hinged and holds a compartment with all electronics other than the system PC. Removing the knurled hand-screw provides access to this compartment. This is for service access only. There are no user adjustments or controls behind the hinged back.

6. MEASUREMENT STRATEGY

HVR systems include a .090X telecentric lens. Magnification is the image size at the camera charge coupled device (CCD) detector divided by the object size. For example, a 2.0-inch circle would be .18-inches on the CCD array (2.0 x .090=.18). This value is different than total magnification, which is the size of the object on the monitor.

6.1 Measurement Accuracy and Depth of Field

The telecentric lens included with the system provides high accuracy, high throughput field-of-view (FOV) measurements. The 0.090 lens accommodates parts up 92.7 mm x 76.2 mm (3.65 x 3.0 inches).

Accurate measurement requires proper focus of the image. When measuring flat parts, always ensure that the stage glass has been leveled.

Always work at best focus. 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 approximately 10 microns or better for a one-inch object. The most repeatable results can be achieved by taking the time to adjust focus using digital zoom. Focus is determined by digitally zooming in on the edge of an object and adjusting focus until the pixels appear on that edge. This ensures the best and most repeatable measurements are obtained. See the figures below that illustrate poor focus and good focus.

Note: *For best results, view these figures online with a high-resolution monitor. A printed version of these figures does not provide a clear distinction of difference between good and poor focus.*

Example of Object with Poor Focus

Example of Object with Good Focus

6.2 Lighting and Illumination 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.

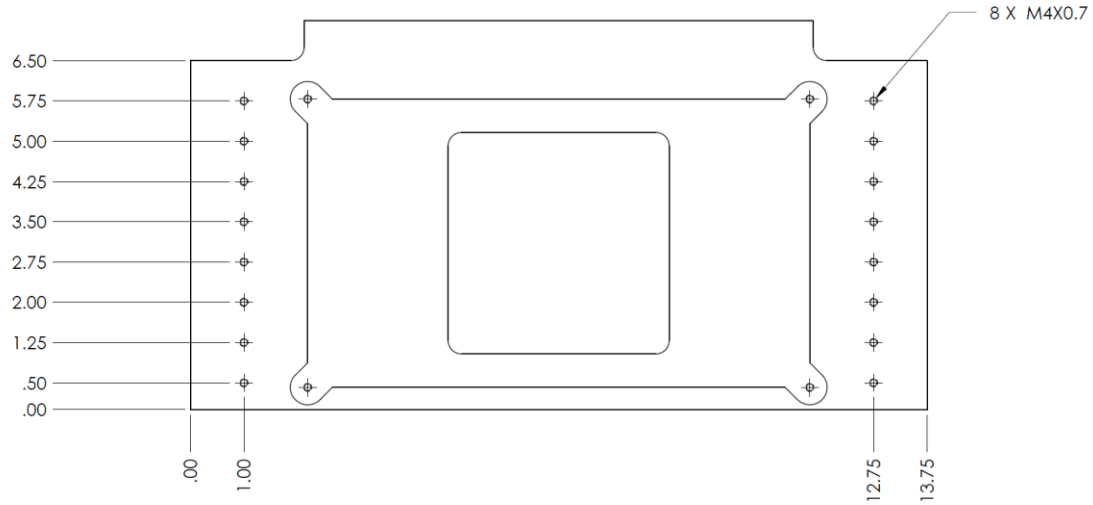
When adjusting lighting, start with light that is lower than desired, then increase lighting while viewing the image on the computer monitor. Maintain constant lighting for consistent results. Do not to change light levels between points used to measure the same geometrical feature.

Depending on the part characteristics and the feature being measured, the right combination of lighting might aid in bringing out a particular feature. Take time to experiment by balancing the available light sources.

6.3 Parts Fixturing

The part must be fixtured securely to prevent part movement during measurement. Also, proper alignment of the part to the stage can aid in measurement. Orientation errors, or skew errors, can also be removed by creating a reference frame based on the part before taking measurements. See the M3 software manual for details.

The following illustration provides the location of the tooling holes on the system. Use these locations to customize the system to your operating requirements.



HVR100 Tooling Holes

6.4 M3 Software Operation

M3 software operation is outside the scope of this hardware-oriented user manual. Refer to the separate MetLogix M3 software manual for detailed information.

7. SYSTEM MAINTENANCE

HVR metrology systems have been designed for years of superior service. Periodic maintenance as outlined in this section is considered good practice 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.
- Schedule regular factory-authorized calibration and maintenance service to preserve proper function and accuracy.
- Replace batteries when needed for wireless keyboard and wireless mouse. Have alkaline AA batteries on hand for the mouse and AAA batteries for the keyboard.

Wireless Mouse Battery Placement

Wireless Keyboard Battery Placement

7.1 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 cords are plugged into a grounded power source and are unobstructed.
- Verify that temperature and humidity are within recommended ranges.

7.2 Weekly Inspections

On a weekly basis, or if the system has been moved, do the following:

- Verify that the stage control mechanisms move freely. If binding is observed, call for service. The lead screw uses a self-lubricating TFE coating, which is designed to last for the life of the product. Do not apply cleaner or lubricant.
- Do a basic calibration check against a certified chrome-on-glass standard, such as Accurite 25mm fiducial. Do a single measurement on an artifact whose dimensions are comparable to those of the parts to be measured and verify that the measured dimensions are within the HVR's specifications.

7.3 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 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.

7.3.1 Cleaning External Surfaces

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

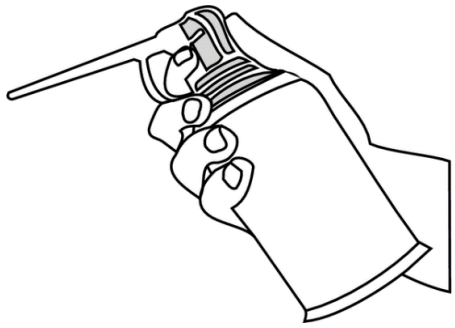
7.3.2 Cleaning Optics

	**WARNING:** Do not touch lens surfaces with your fingertips. Fingerprints might 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 might blow onto the lens. As alternative, 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 tissue or a lens cloth. These items are available from camera stores. Apply the lens cleaner generously to dissolve the grease, and 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 could scratch the optical coatings.

If the greasy deposits do not come off with the lens cleaner, use a stronger solvent such as reagent-grade acetone as a last resort. Gently wipe the lens surface while moving the lens cloth to always present a clean 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.



Optical Grade Compressed Air

7.3.3 Cleaning Critical Mechanical Parts

Critical components are covered and are not user serviceable. Should the stage mechanics bind or require service, contact your Starrett representative. The lead screw uses a self-lubricating TFE coating, which is designed to last for the life of the product. Do not apply cleaner or lubricant, which could collect dirt and impair system performance.

7.3.4 Recommended Spare Parts

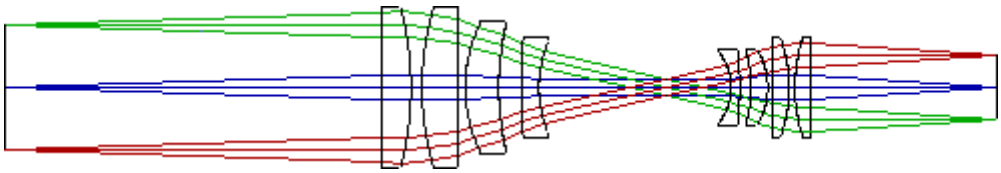
The only recommended spare part is extra stage glass in case the original breaks or cracks.

8. GLOSSARY

The following terms might have additional meanings. The definitions that follow are in the context of the HVR metrology systems.

Term	Definition
Accuracy	The maximum error that the system will produce when measuring a true standard.
Axis	A direction which allows movement and along which dimensions can be measured. In the HVR systems, the X-axis is horizontal from left to right, and the Y-axis is from front to back, and the Z-axis is from bottom to top.
Blooming	A condition where the parts of the video image are distorted by oversaturated bright regions, making illuminated regions appear larger than they really are.
Camera Alignment	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. (Only applies to systems with X and Y stages.)
CCD	Charge Coupled Device. The solid-state image sensing element of the video camera.
Distortion	Optical image distortion at the CCD sensor across the maximum field of view. Expressed in percent for the dimensional error along one axis divided by the true dimension.
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.
Field of View (FOV)	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 when the object is viewed by the camera.
Mag	Abbreviation for magnification.
Magnification, Lens	In a metrology system, the image size in the CCD plane divided by the corresponding object size.
Magnification, Image	Magnification on monitor. Image size on the video monitor divided by the corresponding object size. Same as lens magnification in a properly adjusted optical comparator.

Term	Definition
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.
Resolution	The least significant digit to which a physical quantity can be read. High resolution does not imply high accuracy.
Skew	Misalignment of the part with respect to the X and Y axes. This will create measurement errors unless the part is repositioned or the deskew feature of the metrology software redefines the measurement axes.
Substage Lighting	Illumination from below the stage glass. Used for profile or silhouette video edge measurements.
System PC	A space saving personal computer where all electronics, disk drives and I/O connections are in the same enclosure as the video monitor, which is an LCD color touch-screen. A keyboard and mouse are also included.
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. See the figure below.
TFE	Tetrafluoroethylene, a self-lubricating polymer coating used on precision lead screws.
VED	Video Edge Detection, a system where a video camera and digital image processing are used to detect edges or other features.



Telecentric Lens