MVR200 & MVR300
Manual Video Metrology Systems
User Manual

Starrett Kinemetric Engineering

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Table of Contents

1. PREFACE

1.1 Welcome

Thank you for purchasing an MVR200 or MVR300 Manual Video Metrology 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 in order 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 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 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.
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 (SKE) products carry a one-year warranty from date of purchase against defects in material or 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 material or workmanship. 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

The MVR200 and MVR300 Video Metrology Systems have been inspected, tested, and evaluated by independent test laboratories and are declared to comply with Council Directives 2006/42/EC - Machinery and 2002/95/EC RoHS (by exemption) when installed and operated in accordance with this manual. 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

EN 61326-1:2013 **CISPR 11:2003+A1:2004 +A2:2006**	Radiated and Conducted 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

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

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. PRODUCT DESCRIPTION

2.1 Overview

The MVR Series of advanced benchtop manual video metrology system consists of two base models: the MVR200 with 200 x 100 x 200 mm (8” x 4” x 8”) of X-Y-Z travel, and the MVR300 with 300 x 200 x 200 mm (12” x 8” x 8”) of X-Y-Z travel.

Both MVR models feature a granite base for stability, recirculating ball linear guides for smooth stage motion, and a motorized Z-axis. All electronics other than in the system’s PC are housed in the Z-column, providing a clean, integrated system with minimal external wiring. Two high-speed data cables carry all signals between the metrology unit and PC. Superb metrology performance is provided by 0.5 micron resolution linear encoders, a high-resolution color video camera, two-channel LED lighting, and precision optics, which can be 6.5:1 manual zoom optics or any of six telecentric lenses for field-of-view (FOV) measurements. FOV measurements can encompass an entire small part up to 2.00” x 1.50” or a feature of a larger part and be seamlessly integrated with stage motion to measure parts with a length up to 200 mm (MVR200) or 300 mm (MVR300).

The operator interface is a 21.5” all-in-one touch screen PC which runs MetLogix M3 FOV software under Windows® 7 Professional. This software supports 3-axis measurements and 2D geometrical constructs (points, lines, angles, and rectangles). The screen displays a live video image of the part plus geometry tools and digital readings. The image of the part can be resized using zoom, and measurements can be taken by simply tapping a feature on the screen. A keyboard and a wireless mouse are also provided, and are used for file operations.

With the M3 DXF/FOV option pack, DXF CAD files can be imported over a network and be automatically compared to actual measurements.

2.2 MVR Options

The MVR Series is available as basic MVR200 or MVR300 systems with factory installed manual zoom optics, and as MVR200 or MVR300 FOV systems with a bayonet lens mount for quick change of optics by the user.

- The basic MVR200 and MVR300 systems come with a 1 Mpixel color video camera and 6.5:1 manually adjustable zoom optics. Two-channel illumination is provided by an LED ring light and collimated LED sub-stage lighting.
- The MVR200 FOV and MVR300 FOV systems come with a 2 Mpixel color video camera and a bayonet lens mount which accepts a 6.5:1 manual zoom lens or any of six available fixed magnification telecentric lenses (0.30X, 0.50X, 0.80X, 1.0X, 2.0X, 4.0X), where the stated magnification is the image size on the camera CCD divided by the corresponding object size.

Options include auxiliary lenses for the zoom optics (0.5X, 1.5X, 2.0X), a choice of NIST-traceable calibration standards, and an ergonomic workstation.

3. System Specifications

Feature	MVR200	MVR300
Measurement Range, X-Y-Z	200 x 100 x 200 mm (8" x 4" x 8")	300 x 200 x 200 mm (12" x 8" x 8")
Unit Dimensions, H x W x D	865 x 600 x 645 mm (34" x 23.7" x 25.4")	865 x 790 x 865 mm (34" x 31" x 34")
Metrology Base	Granite	
Reading Resolution, X-Y-Z	0.5 µm (0.00002")	
E2 Accuracy (X & Y)	2.5 µm + 5L/1000	
E1 Accuracy (Z)	2.5 µm + 5L/1000	
Motion Control	Manual X and Y, motorized Z	
Substage Illumination	LED illumination matched to camera optics	
Surface Illumination	LED ring light	
Camera Resolution	1 MP (1024 x 768 pixels) for basic models with dedicated zoom optics 2 MP (1620 x 1236 pixels) for models with bayonet lens mount	
Image Update Rate	15 frames/sec, including image processing	
Computer Hardware	All-in-one PC with 55 cm (21.5") color touch screen, 4 GB RAM	
Computer Interfaces	Ethernet (1 GB/sec), Wi-Fi, four USB 2.0 ports	
Data Storage	500 GB hard disk	
Operating System	Windows® 7 Professional	
Application Software	MetLogic M3 metrology software and DXF/FOV option pack	
Geometrical Constructs	2D geometries plus height	
Comparison to CAD Files	DXF CAD file import, automatic comparison to CAD files	
Operator Controls	Computer touch-screen, keyboard with integral touchpad	
Optics Mounting	Fixed mount or bayonet fitting for quick optics changes	
Power for Metrology Unit	"Brick" type AC adapter, 100/240 Vac input, 24V, 5A output	
Power for All-in-One PC	"Brick" type AC adapter, 100/240 Vac input, 19.5V, 7.9A output	

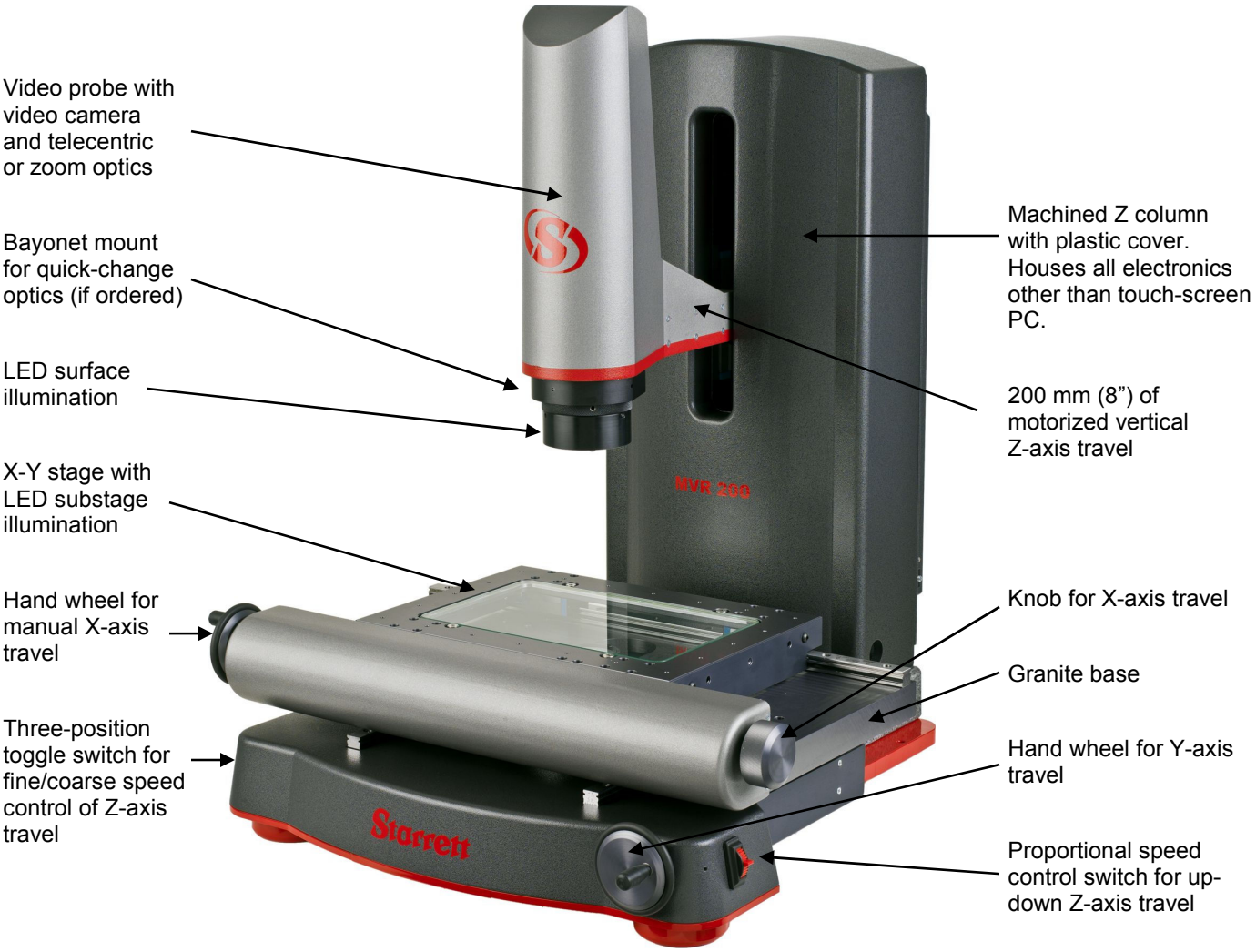
Zoom Optics	6.5:1 Zoom
Magnification on CCD	0.70X to 4.50X
Field of View Width	10 to 1.6 mm (0.39" to 0.06")
Magnification on Monitor	31X to 200X
Zoom Working Distance	88 mm
Available Auxiliary Lenses	0.5X, 1.5X, 2.0X

Telecentric Optics	0.30	0.50	0.80	1.0	2.0	4.0
Magnification on CCD	0.30X	0.50X	0.80X	1.0X	2.0X	4.0X
Magnification on Monitor	13X	22X	36X	45X	89X	178X
Field of View Width	24 mm 0.93"	14 mm 0.56"	8.9 mm 0.35"	7.1 mm 0.28"	3.6 mm. 0.14"	1.8 mm 0.07"
Optical Distortion (ΔH/H)	0.003%	0.018%	0.009%	0.003%	0.006%	0.005%
Telecentric Working Dist.	110 mm					

***** At 1:1 pixel setting

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

3.1 MVR200 & MVR300 System Components



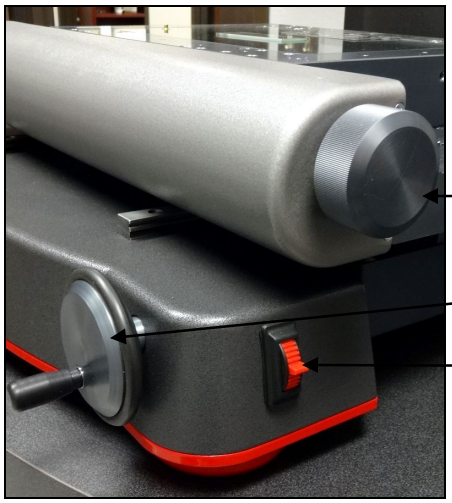
MVR200 benchtop vision metrology system

3.2 Operator Controls and Electrical Connections

Operator Controls on Left Side

Hand wheel with crank for X-axis motion

Three-position toggle switch for fine/coarse speed control of Z-axis travel.

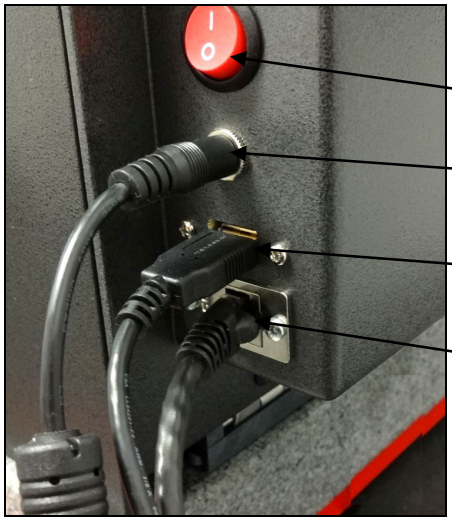


Operator Controls on Right Side

Knob for X-axis motion. Attached to same shaft as hand wheel on left side of machine.

Hand wheel with crank for Y-axis motion

Proportional speed control switch for up-down Z-axis travel



On-Off Switch and Electrical Connections

On-Off switch. Used to turn machine off when not in use.

24 Vdc power input from 'brick" type power supply on floor.

USB connection to all-in-one PC for encoder signals.

USB or Ethernet connection to all-in-one PC for camera signal. The choice of USB or Ethernet depends on the type of camera.

Electronics Compartment in Back

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

3.3 Changing Optics Assemblies

MVR systems equipped with a bayonet optics mount allow their optics assemblies to be changed quickly by the user, for example to switch from zoom operation to fixed-magnification telecentric measurements, or to switch between telecentric lenses with different magnifications.

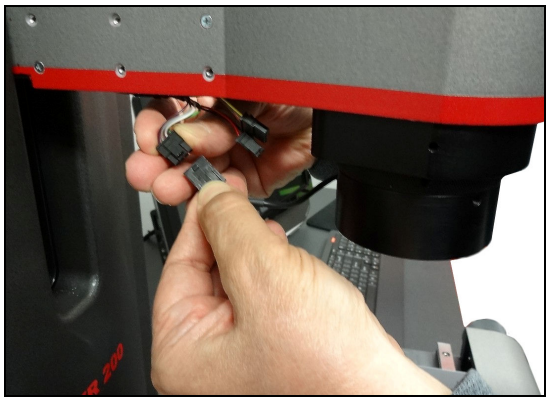
NOTE	The positioning of different optics assemblies in the bayonet mount is not exact, so do not change optics in the middle of a measurement run.

An LED quad ring light is normally part of the 6.5:1 zoom optics assembly and should always remain attached to that assembly. A different LED ring lights fits all telecentric lens assemblies from 0.3X to 4.0X. This ring light can be transferred from one telecentric lens to another when these have been removed from the system.

6.5:1 zoom optics assembly (left), telecentric optics assembly (right)

To remove a lens assembly from the system, first detach the electrical connections of the ring light. Note that the electrical connectors are latched. Pry the plastic latch open with a flat-blade screwdriver, and the two connector halves will separate easily. Give the optical assembly a quarter turn counterclockwise, and the assembly will suddenly be released. Reverse the process to reinstall.

Cautions 	• Use two hands to remove a lens assembly, as it is heavy and is suddenly released after giving it a quarter turn counterclockwise. A drop onto the stage glass could break the lens and the stage, causing expensive damage. • 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. • Place unused lens assemblies in a polyethylene Ziploc bag for dirt protection. • Store unused lens assemblies in a safe place, since they are breakable and expensive.



First unplug the ring light connector.

Then remove optics assembly using two hands.

3.4 Optimizing Substage Illumination

MVR systems with dedicated optics (zoom or telecentric) and without a quick-change bayonet lens mount are shipped with LED substage illumination that is optimized for these optics. No action is required by the user.

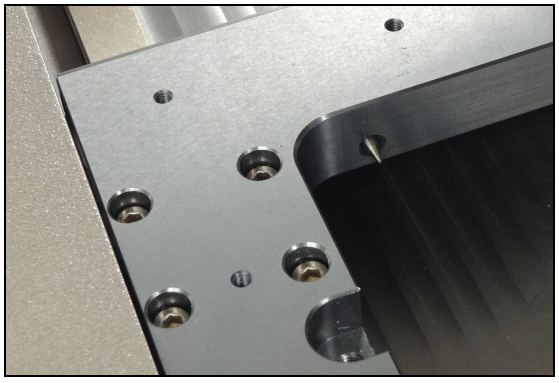
MVR systems with the quick-change bayonet lens mount require that substage illumination be modified when switching between telecentric and zoom optics, since a smaller aperture will produce better results with zoom optics. This is achieved by reducing the aperture of a variable aperture if such an aperture is part of the system, or by dropping in an aperture plate if furnished with the zoom optics.

Access to the substage lighting requires that the glass plate be removed from the MVR stage. To do so, remove the four screws that secure the glass plate to the stage. Once these have been removed, place two fingers in the spaces vacated by the screws and pry up one side of the glass pate. Better yet, use a suction cup to pull up one side of the glass plate.

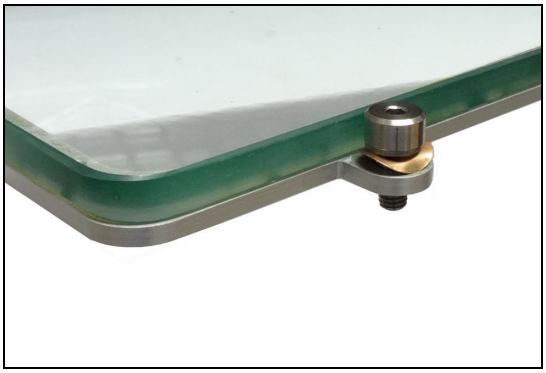
3.5 Mechanically Leveling the Stage Glass

The glass plate can be considered level if the video image of an artifact remains in focus at high optical magnification for any stage position. MVR systems allow the glass plate to be leveled mechanically by about 1.5 mm using four screws whose head has been machined to a conical tip.

Turn a screw clockwise with a 2.5 mm Allen wrench to move it toward the glass plate and raise the stage. Turn a screw counterclockwise to move it away from the glass plate to lower it. Note that glass does not rest directly on the conical tips, but is held by a steel frame. The glass plate is secured by screws with a spring washer. Orient the washers as shown in the photo below, keeping them barely compressed so that they have an adjustment range. Four-point support will provide pivot action around two diagonal axes, so make screw adjustments until the image remains in focus and the glass plate no longer tips around a diagonal axis.



Conical tip, indentation for attachment screw with spring washer



Glass plate with steel base and attachment screw with spring washer

3.6 Operational Values

MVR 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

MVR 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

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.

Before performing critical parts measurements, allow the system to warm up and temperature stabilize for 30 minutes.

3.7 Safety Considerations

General Safety 	MVR vision metrology 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 question regarding transporting, using or maintaining this system.
Electrical Safety 	MVR vision metrology systems do not contain hazardous AC line voltages, as these are contained on the input side of the system's two AC adapters, which are UL listed. The supplied voltages are 24 Vdc to the metrology unit and 19.5 Vdc to the all-in-one PC. Even at these low voltages, there is the potential of electrical equipment 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.
Mechanical Safety 	• MVR systems are heavy. To avoid possible back injury, use multiple persons to lift. Bend your knees, not your back. • There are moving components and potential pinch points, so do not place hands and mechanical items near pinch points. The risk of injury from these pinch points is minimal, since all motion is slow and manual, not motorized.

3.8 Equipment On/Off Control

MVR systems have two On/Off switches: one on the back right of the metrology unit right above the electrical connections, and one in the upper left of the all-in-one PC. Turn the system off when not in use.

	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.

3.9 Fuses

There are no fuses in the system.

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.

4.1 Moving the Equipment

MVR metrology units 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 may damage its contents.

4.2 Uncrating the Equipment

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

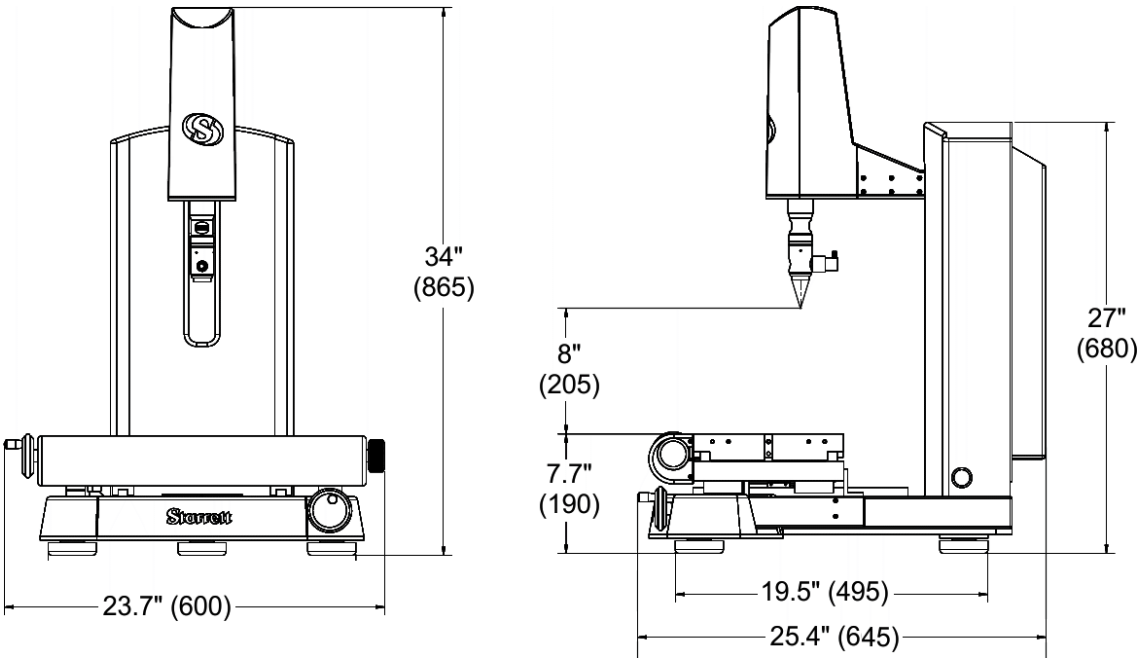
1. Battery powered drill with Phillips bit (to remove top and sides of shipping crate).
2. Crescent wrench (to remove screws which attach shipping tabs to the crate).
3. Bubble level (optional, to level workbench or workstation).
4. Other common hand tools.

4.3 Placing the Equipment

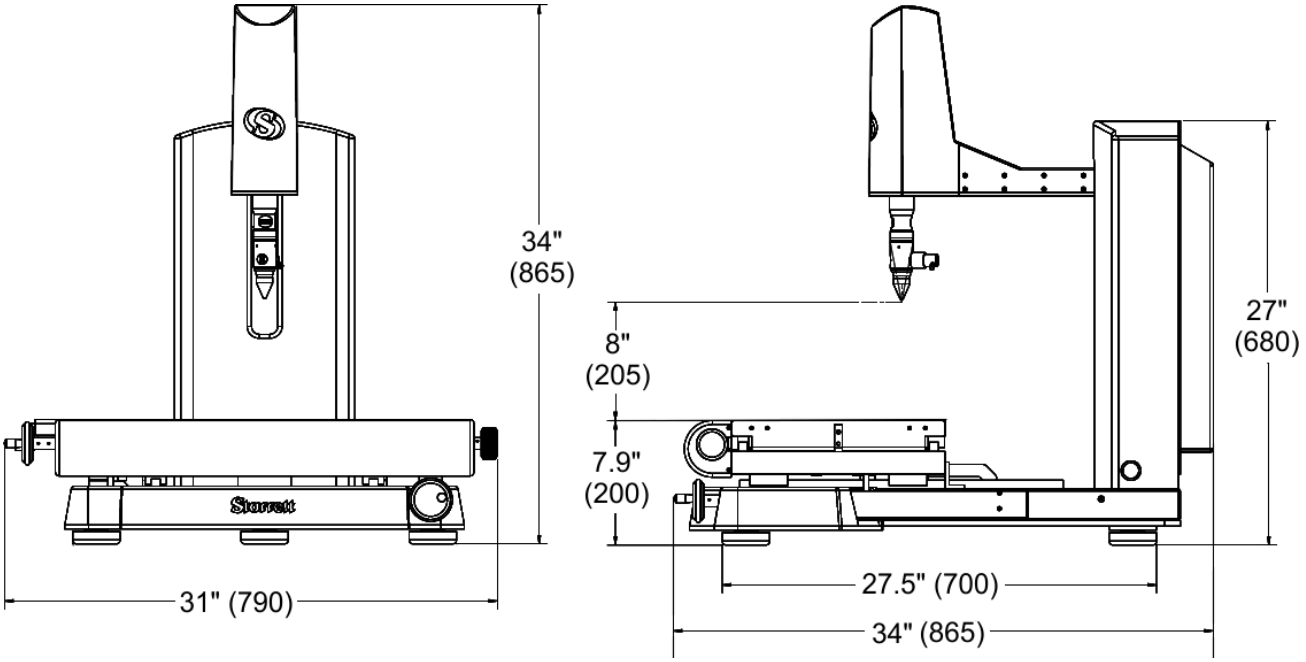
A clean operating environment is recommended to minimize the accumulation of dirt on the optics and on precision mechanical parts, such as lead screws and encoder scales.

MVR systems are designed to be installed on a benchtop at a height of approximately 85 cm (33.5”), 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”) to right or left side of the metrology unit to position the all-in-one PC. An additional clearance of 30 cm (12”) on both sides is recommended for general access. Allow a minimum of 5 cm (2”) behind the unit for air floor, as the electronics compartment only uses convective air cooling. Please refer to the drawings below for dimensions of the MVR200 and MVR300 metrology units.

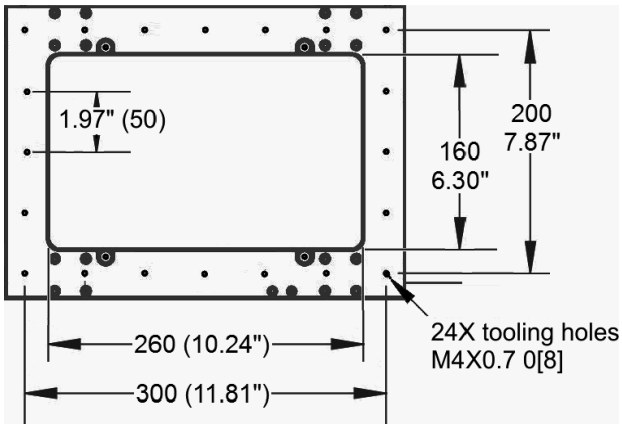
Completely opening the hinged door at the back of the metrology unit for service access requires an additional 50 cm (20”) of space. The metrology unit can be moved as needed for service.



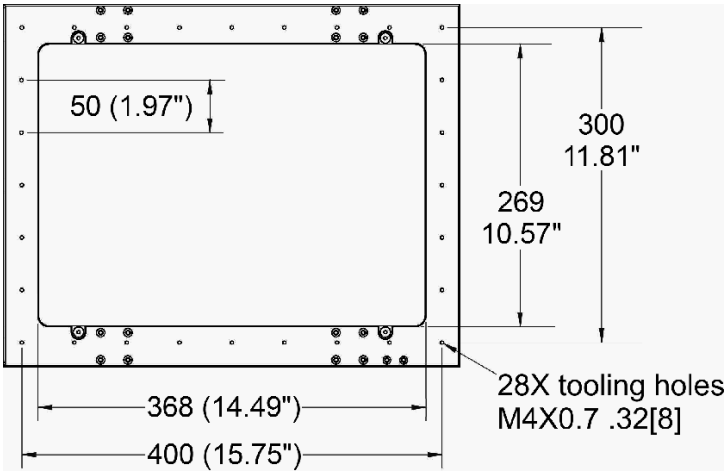
MVR200 metrology unit dimensions



MVR300 metrology unit dimensions



MVR200 glass dimensions and tooling holes



MVR300 glass dimensions and tooling holes

4.4 Removing Shipping Retainers

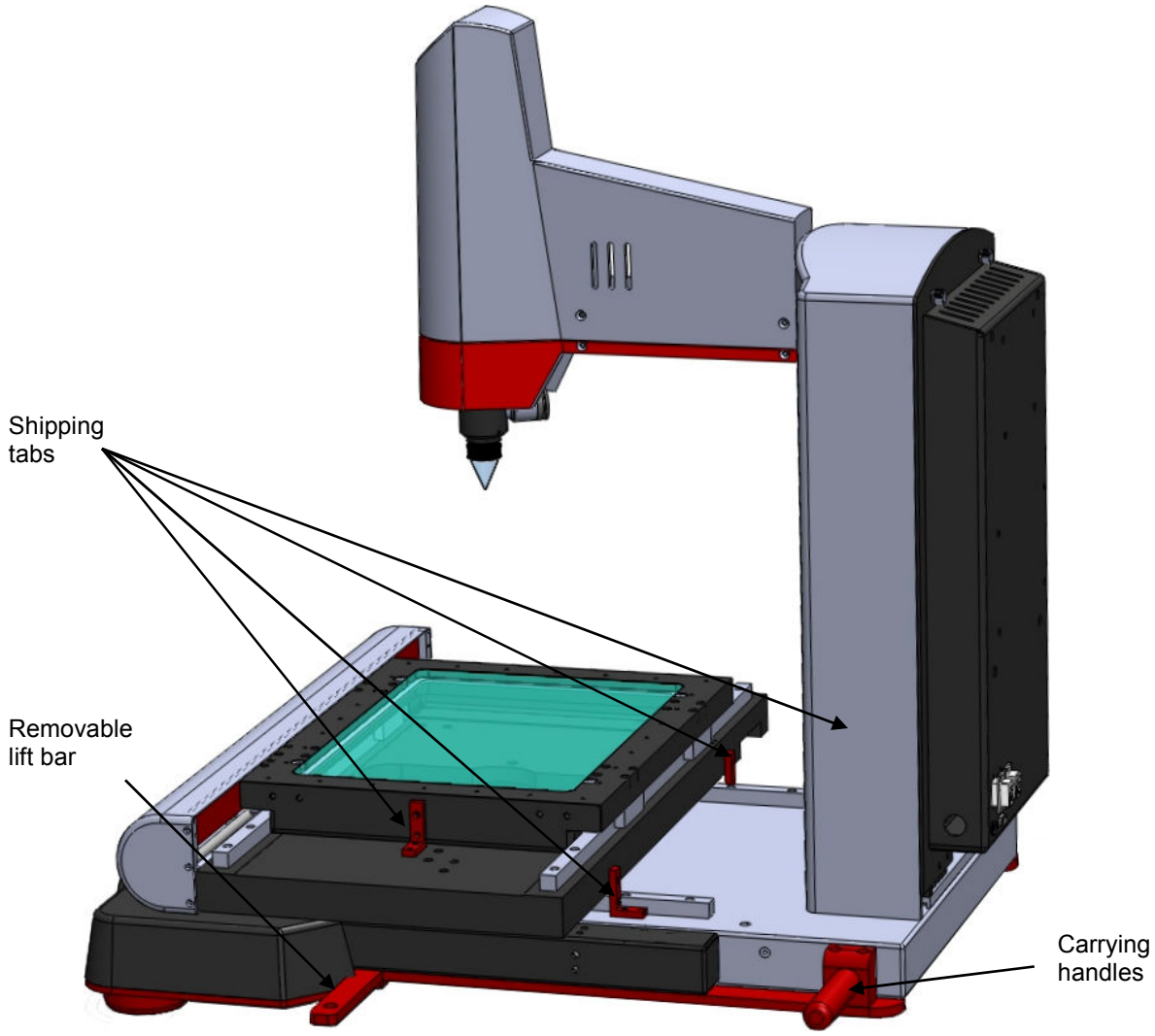
MVR systems (and other Starrett metrology systems) use metal tabs to prevent movement of critical components during shipment. Anodized red for easy identification, these are intended to be removed once the equipment has been placed in its final position. Look for any red tabs and remove them. There is also a red tab inside the electronics housing, so open the hinged door at the back of the metrology unit and remove that tab also.

MVR300 metrology units are shipped with two red carrying handles near the back of the base. These can be removed or be left on the system following installation to facilitate possible later lifting.

MVR300 metrology units are also shipped with a lift bar toward the front of the base. This bar is used to secure the units in their shipping crate and can also be used for lifting. This bar slides out and is normally removed once the system is installed.

Also remove any tape and packing materials that may have been added for shipment.

Please refer to the drawings below for the locations of MVR300 red retainer tabs, carrying handles, and the lift bar.



Location of MVR300 red retainer tabs, lifting handles, and slider bar

4.5 Electrical Connections

MVR systems are powered by two “brick” type AC adapters, one for the metrology unit (19.5 Vdc output) and one for the all-in-one PC (24 Vdc output). Both accept 100/240 Vac power for worldwide use. The maximum combined current draw is 3.6A at 120 Vac or 1.8A at 240 Vac. Verify that the power outlet is rated for at least these currents.

The adapters are normally placed on the floor. Before doing so, verify that the floor will never 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.

4.6 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 an MVR manual system.

On-site basic operator training is provided following calibration. This typically takes 1/2 day for an MVR manual system. Many customers choose to augment basic training with additional hands-on training, where new operator’s 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

MVR systems can be operated with any of 6 telecentric fixed-focus lenses with magnification from 0.30X to 4.0X or with 6.5:1 zoom optics with continuously adjustable magnification from 0.7X to 4.5X. Magnification is the image size at the camera CCD detector place divided by the object size. Since the CCD size is fixed (namely 9.93 x 8.70 mm for the 2 Mpixel camera), 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.

Note that the centering of the optics can vary by a small amount in the quick-change bayonet optics mount, so all measurements on the same part need to be taken with the same optics.

5.1 Telecentric Lens Measurement Strategy

Select telecentric optics to perform high accuracy, high throughput field-of-view (FOV) measurements. If all measurements are to be in the FOV, select the highest magnification lens whose FOV encompasses the entire part. The 0.30X lens accommodates parts up to 51 x 38 mm (2.00” x 1.50”). If the entire part cannot fit into the FOV, no problem. Simply move the stage by up to 200 mm (8”) for the MVR200 or 300 mm (12") for the MVR300, and the M3 software will seamlessly integrate FOV measurements with encoder readings from stage motion.

5.2 Zoom Optics Measurement Strategy

The 6.5:1 zoom optics allows magnification to be continuously adjusted from 0.7X to 4.5X. While the zoom optics can provide the same FOV as the four higher magnification telecentric lenses, they do not offer the same low optical distortion that is required for accurate FOV measurements across the entire FOV. However, they are equally as accurate as telecentric lenses when used at high magnification in combination with stage motion.

Select zoom optics to measure large parts which would not fit into a single FOV, also for smaller parts where extremely high magnification is required. The lowest zoom magnification setting accommodates parts up to 11.2 x 9.4 mm (0.44" x 0.37") in the FOV. To measure large parts, locate the edge of interest at minimum magnification, then take the actual measurement at maximum magnification using the system's crosshairs. The zoom optics’ parcentricity feature will ensure that a feature will remain at the optical center of the video image throughout the magnification range.

5.3 Illumination Strategy

Once the image has been properly focused and magnification has been set, adjust light levels as necessary using the slider controls in M3 software. The right lighting is paramount to accurate measurement with any video-based measurement system. 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 blooming, or oversaturated bright regions that distort features.

When adjusting lighting, start with light that is lower than desired, then increase lighting while viewing the image on the monitor. Maintain constant lighting for consistent results. Always use the same light level while sampling points for a single feature – do not to change light levels during a measurement run.

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

5.4 Magnification Strategy

In general, higher magnification provides greater resolution and accuracy; however, not all features should be inspected at the highest available magnification. Too high a magnification may make it difficult to discern edges by exaggerating edge defects such as burrs or chips. Try decreasing the magnification until the edge is more clearly identifiable.

Also consider factors such as tolerance requirements, manufacturing processes, functional requirements and optical characteristics of the part. Features with loose tolerances may not need to be inspected at high magnification. Select the magnification best suited for the requirements.

5.5 Focus Strategy

Accurate measurement requires proper focus of the image. When measuring flat parts, always first ensure that the stage glass has been leveled. When using zoom optics, first focus the image at highest magnification, then decrease the magnification to the desired level.

5.6 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. If the part is off-axis from the stage, X-Y-Z measurements will not correlate as well with the part dimensions. Aligning the part with the X, Y and Z axes of the system will improve dimensional measurements. Orientation errors, or skew errors, can also be removed by creating a reference frame based on the part before taking measurements. Please see the M3 software manual for details.

5.7 M3 Software Operation

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

6. SYSTEM MAINTENANCE

MVR vision metrology systems have been designed for years of superior service. Periodic maintenance as outlined in this section should be performed to maintain the system in peak operating condition.

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.

6.2 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 screws use 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 Starrett's MAG Checker, P/N 3297. With a telecentric system, 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 AVR's specifications. With a zoom system, measure artifacts at the zoom detent positions for maximum and minimum magnification..

6.3 Zoom Optics Alignment Verification

The system's zoom optics (if part of the system) should be verified regularly to ensure accurate measurement. Parfocality, parcentricity and squareness verifications are straightforward and may be performed as often as desired.

	**CAUTION:** While optical alignment verification may be performed by an operator, optical alignment correction should only be performed by an authorized service technician. If alignment discrepancies are found, contact Starrett or your local Starrett representative to schedule authorized service.

6.3.1 Zoom Optics Parfocality & Focus

Parfocality is the condition in which the video image remains focus as the magnification is adjusted from highest to lowest. Starrett zoom optics are designed to maintain parfocality throughout their magnification range.

To check parfocality, always reference a flat, sharp edge. Do not select a rough or sloping feature. The MAG checker provided with the system is an ideal part to check parfocality.

Steps to check parfocality:

1. Place the MAG checker or other suitable inspection part on the stage and secure properly.
2. Backlight the image as necessary. Set light levels as needed to avoid blooming.
3. At low magnification, select a flat, sharp edge in the center of the field of view (FOV).
4. Select highest magnification, and carefully refocus the image by physically changing the viewing distance.

5. While observing the feature, slowly adjust the magnification lower. Verify that the feature remains focused as the magnification is lowered.
6. Report any observed discrepancy. If the error is verified, contact your Starrett representative for authorized service.

6.3.2 Zoom Optics Parcentricity

Parcentricity describes the condition wherein a feature remains at the optical center of the video image throughout the magnification range. Like parfocality, parcentricity requires that the feature be first located at highest magnification.

Steps to check parcentricity:

1. Place the MAG checker or other suitable inspection part on the stage and secure properly.
2. Select the crosshair image tool and verify that it is at its defined center position. Please refer to the M3 manual for details on centering the crosshair. The crosshair is to remain at this position during the parcentricity test.
3. Zoom to low magnification, and adjust the stage position so that the crosshair is centered on the X-Y axis of the calibration standard (or another suitable feature if the standard is not used).
4. Change to high magnification and refocus the image.
5. Adjust the stage position as needed to recenter the crosshair on the feature.
6. While observing the feature, slowly adjust the magnification lower. Verify that the feature remains at the center of the crosshair as the magnification is lowered.
7. Report any observed discrepancy. If the error is verified, contact your Starrett representative for authorized service.

6.3.3 Zoom Optics Squareness

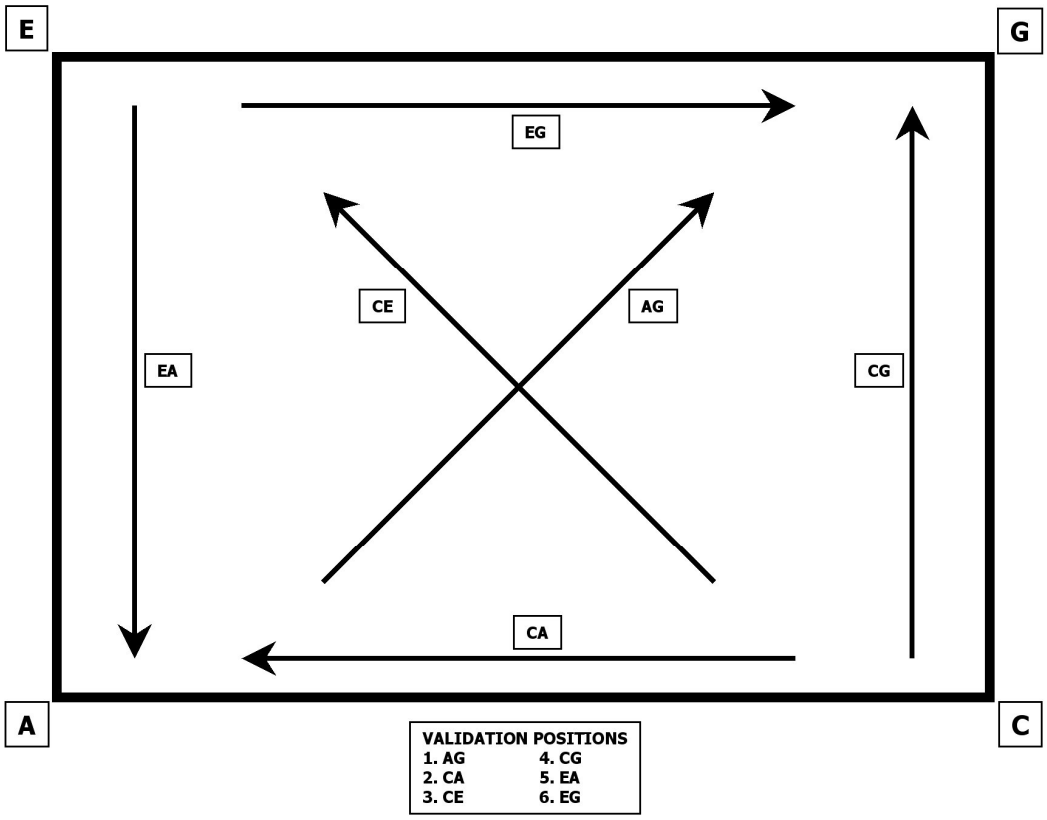
Squareness refers to the alignment of the camera relative to the motion of the metrology stage. If the camera is misaligned (out of square), an image will appear to drift diagonally across the video image as the stage position is moved along one axis.

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. At low mag, 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. Zoom to high magnification, then refocus and recenter the point as needed.
5. 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
6. Report any observed discrepancy. If the error is verified, contact your Starrett representative for authorized service.

6.4 Calibration Verification

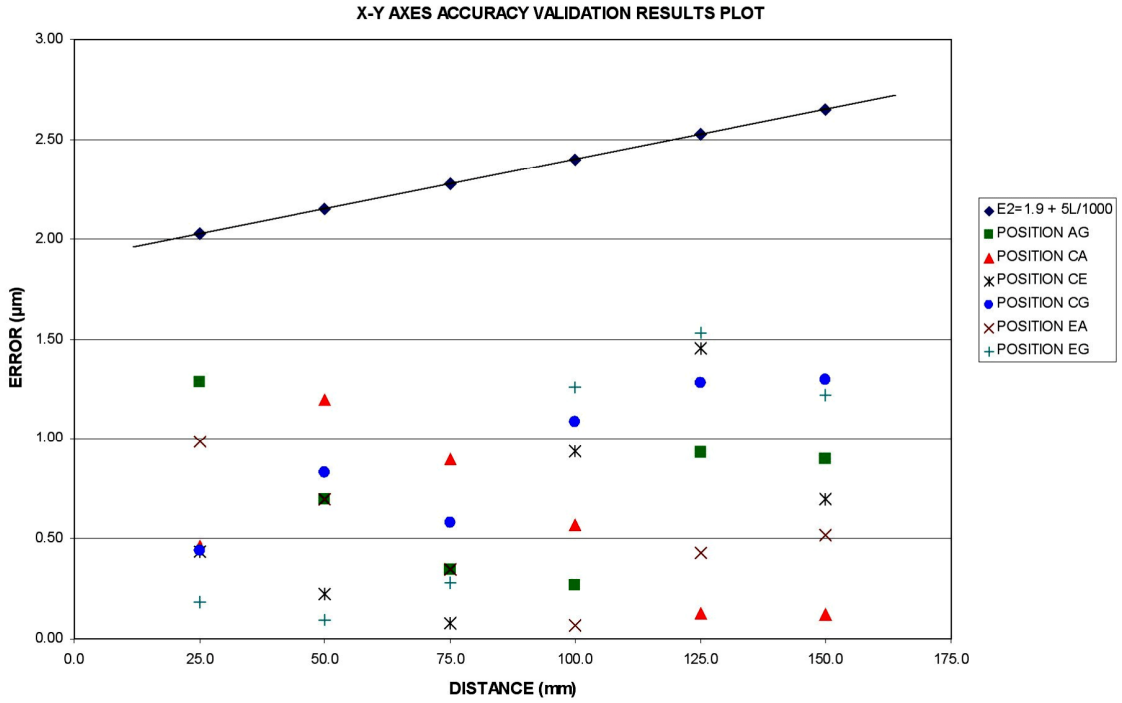
Calibration should be verified periodically depending on user requirements and systems usage, and should be at least monthly. A calibration verification standard artifact is available from Starrett authorized distributors or directly from the Starrett service department. Calibration should also be verified after the system has been serviced or moved. The following is a brief description of the steps recommended for the verification of your machine.



Verification Standard Placement

Steps to validate calibration:

1. Place the calibrated verification standard in one the six positions on the glass stage as shown above. Secure the standard with hot melt glue or other suitable retaining method so that stage translation can not move the standard under any condition.
2. Skew the center of the two end circles. Please refer to the M3 software manual for proper alignment procedures.
3. Measure the distance between the 1st and 2nd, 1st and 3rd, 1st and 4th, 1st and 5th, and the 1st and 6th fiducials. Repeat these measurements 10 times.
4. Calculate the absolute average deviation for each of the 5 groups of distance measurements.
5. Repeat the measurements for all six locations shown in the illustration.
6. The absolute averages should be within factory system specifications, and be derated for the environment and calibration errors.



Calibration Error Chart Example

6.5 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.

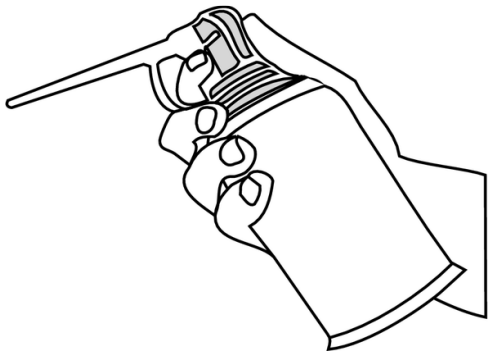
6.5.1 Cleaning External Surfaces

To ensure a long, trouble-free service life, wipe down the system regularly to remove any external dust or dirt. 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.

6.5.2 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 an alternative, use a lens brush to gently wipe off the dust.



Optical grade 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 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 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.

6.5.3 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 screws use 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. GLOSSARY

The following terms may have additional meanings. The definitions that follow are in the context of the MVR video metrology systems.

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

All-in-one 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.

Axis A direction which allows movement and along which dimensions can be measured. In the MVR 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.

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.

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 when the object is viewed by the camera.

Mag Shorthand for magnification.

Magnification, Lens In a vision metrology system, the image size in the CCD plane divided by the corresponding object size (0.30X to 4X for MVR telecentric lenses, 0.70X to 4.50X for 6.5:1 MVR zoom optics).

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.

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.

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.

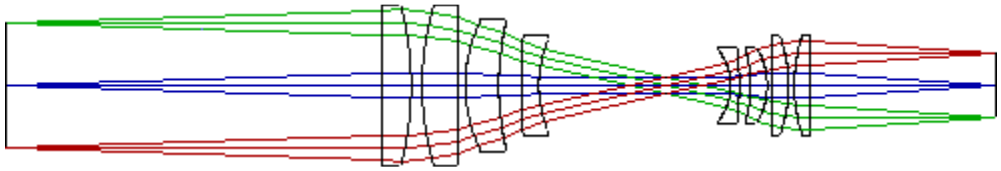
Resolution The least significant digit to which a physical quantity can be read. High resolution does not imply high accuracy.

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.

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.

Substage Lighting Illumination from below the stage glass. Used for profile or silhouette video edge measurements.

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

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 and other features.

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