MV350, MV450 Manual Vision Metrology Systems with MetLogix M3 Software

User Manual

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Table of Contents

1. PREFACE

1.1 Welcome

Thank you for purchasing an MV350 or MV450 Manual Vision metrology system with MetLogix M3 software. 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. Please feel free to contact Starrett 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
	Accompanies a **DANGER**, **WARNING** or **CAUTION** message. Failure to heed the message may result in personal injury or equipment damage. See terms below for further information.
	**WARNING:** Risk of Electrical Shock. Failure to observe this warning may result in personal injury or equipment damage.
	**WARNING:** Disconnect equipment from power source. Failure to observe this warning may result in personal injury or equipment damage.
	**CAUTION:** Pinch Point - Keep hands clear. Failure to observe this warning may result in personal injury or equipment damage.
	**NOTE** with information that is useful or helpful in operating the equipment properly.
DANGER	Immediate hazards which **WILL** result in severe personal injury or death.
WARNING	Hazards or unsafe practices which **COULD** result in severe personal injury or death.
CAUTION	Hazards or unsafe practices which **COULD** result in minor injury or equipment damage.

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

MV350 and AV450 CNC Vision Metrology Systems comply with Council Directives 2006/42/EC - Machinery. When installed and operated in accordance with this manual, they are allowed to carry the CE mark. Testing and evaluations were conducted on a sample representing the maximum configuration. The systems also comply with 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 (150khz-80Mhz)
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
EN 60825	Safety of Laser Products

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 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 INTRODUCTION

Starrett's MV350 / MV450 Manual Vision (MV) metrology systems combine a massive granite base, precision mechanics with recirculating ball linear guides for smooth stage motion, video edge detection (VED), and MetLogix M3 vision metrology software with manually controlled X-Y stage motion and motorized Z motion.

Both systems come standard with a machine pedestal which supports the metrology unit on a granite base, and a separate anthro-cart, which supports the system's touch screen monitor, wireless keyboard, and wireless mouse.

X-Y-Z travel is 350 x 350 x 200 mm (14" x 14" x 8") for the MV350 and 450 x 350 x 200 mm (18" x 14" x 8") for the MV450. Both models use the same X-Y stage, with X-Y dimensions of 716 x 549 mm (28.2" x 21.6"). The X position is set by hand wheel on the right and left sides of the stage. The Y position is set by a knurled knob at the front of the stage.

Z travel is 200 mm (8"). Z position is motorized. Operator Z control is by means of a speed toggle switch and a proportional speed control switch.

Superb metrology performance is provided by 0.5 micron (0.00002") resolution Heidenhain linear encoders, a high-resolution color video camera, flexible 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 350 mm (MV350) or 450 mm (MV450).

The system PC can be an all-in-one touch PC with an integral 21.5" touch-screen, or a desktop PC mounted in the pedestal with a separate 23.5" touch-screen monitor, as ordered. Both PCs run MetLogix M3 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. The system's keyboard and a wireless mouse are used for file operations. With the optional M3 DXF/FOV option pack, DXF CAD files can be imported over a network and be automatically compared to actual measurements.

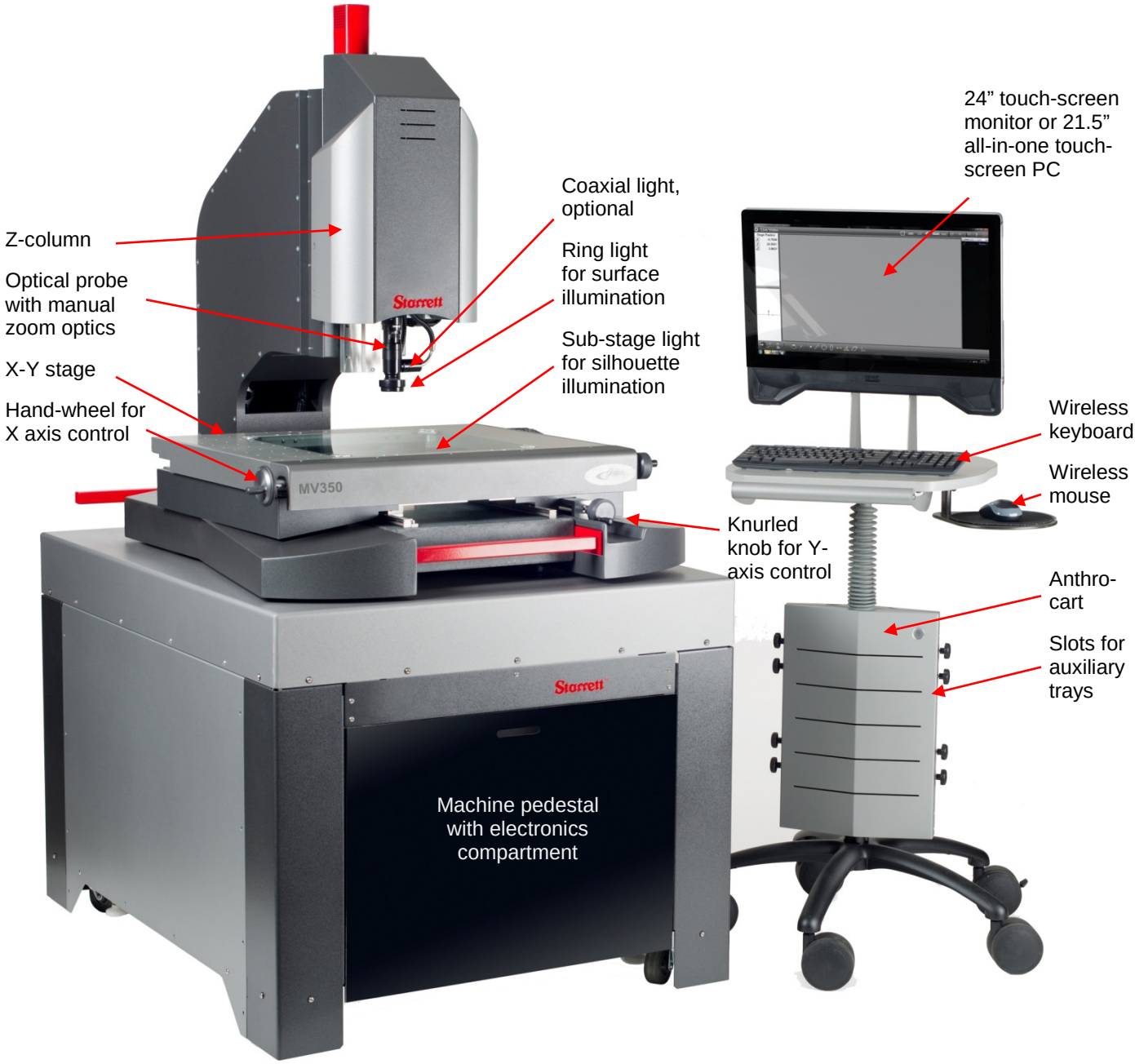
Illumination can be provided by ultra-bright, long-life LEDs, or by quartz halogen lamps with fiber-optic light delivery, as ordered. Two-channel illumination includes a ring light for surface illumination and a back-light for silhouette illumination. Three-channel illumination adds surface illumination that is coaxial with the camera lens. The standard LED ring light can be replaced by a Quad Dark Field (QDF option) ring light, where the LED intensity is individually adjustable in four quadrants. The height of the QDF ring light is manually adjustable on a Z-track for shadow control.

For system Specifications please see the next page. Due to continual product improvement, specifications may change without notice.

CAUTION: Exceeding the system's rated load capacity will reduce accuracy and may damage the mechanical structure.

Feature	MV350	MV450
Physical Configuration	Floor standing system with machine pedestal and anthro-cart for computer interface.	
X-Y-Z Stage Travel	350x350x200 mm (14”x14”x 8”)	450 x 350 x 200 mm (18” x 14” x 8”)
Window Aperture	389 x 389 mm (15.3” x 15.3”)	420 x 540 mm (16.5” x 21.3”)
X-Y Stage Dimensions	716 x 549 mm (28.2” x 21.6”)	
Maximum Workload	18 kg (40 lbs)	
Base	Granite	
Motion Control	Manual X and Y, motorized Z	
X-Y Accuracy	3.5 µm + 5L/1000	
Z accuracy	2.5 µm + 5L/1000	
Error Due to Z Travel	< 7.5 µm per 150 mm (< 0.0003” per 150 mm) before software compensation	
Scale Resolution	0.5 µm (0.00002”), Heidenhain scales	
Control System Software	MetLogix M3 2-1/2 D software (X-Y plus Z for single-axis measurements)	
Light Sources, Standard	Fixed ring light and collimated sub-stage light. Light can from 150-Watt quartz halogen lamp with fiber-optic delivery, or from LEDs, as ordered.	
Additional Light Sources (optional)	1) Through-the-lens coaxial light, fiber-optic or LED. 2) Dark-field quad light with individually adjustable side illumination, LED.	
Quad Ring Light Option Lighting Elements Ring Dimensions Height Adjustment	 96 white LEDs in 4 individually controllable quadrants. 125 mm (5”) OD, 100 mm (3.9”) ID, 19 mm (0.75”) H. 100 mm (4”) Z-track, manually adjustable, height set by thumbscrews.	
Camera Type	1/3” color CCD, 1024 x 768 pixels, USB 2.0 digital interface	
Camera Optics	6.5:1 zoom lens, or fixed telecentric optics, as ordered. Nominal telecentric magnifications are 0.30X, 0.50X, 0.80X, 1.0X, 2.0X or 4.0X.	
Computer System	Built-in desktop PC with 23.5” touch-screen monitor, or all-in-one 21.5” touch-screen PC, as ordered.	
Screen Resolution	1920 x 1080 pixels	
Computer Controls	Touch-screen, wireless keyboard, wireless mouse.	
X-Y Positioning	Hand wheel for X, knurled knob for Y.	
Z Positioning	Motorized. Proportional speed control switch plus coarse-fine speed toggle switch.	
Lighting Control	Programmable under M3 software control.	
Calibration	To NIST traceable calibration standards.	
Machine Pedestal	Supports metrology unit. Houses M3 controller , power supplies, and quartz halogen lamps (non-LED systems). Measures 79 x 93 x 119 cm (31.0” x 36.5” x 47.0”).	
Optional Items	Coaxial illumination, LED quad ring light, auxiliary lenses (0.5X, 1.5X, 2X), parts fixturing, NIST traceable calibration standards.	
Warranty	One year	

2.1 MV350 / MV450 System Components



MV350 / MV450 System Components

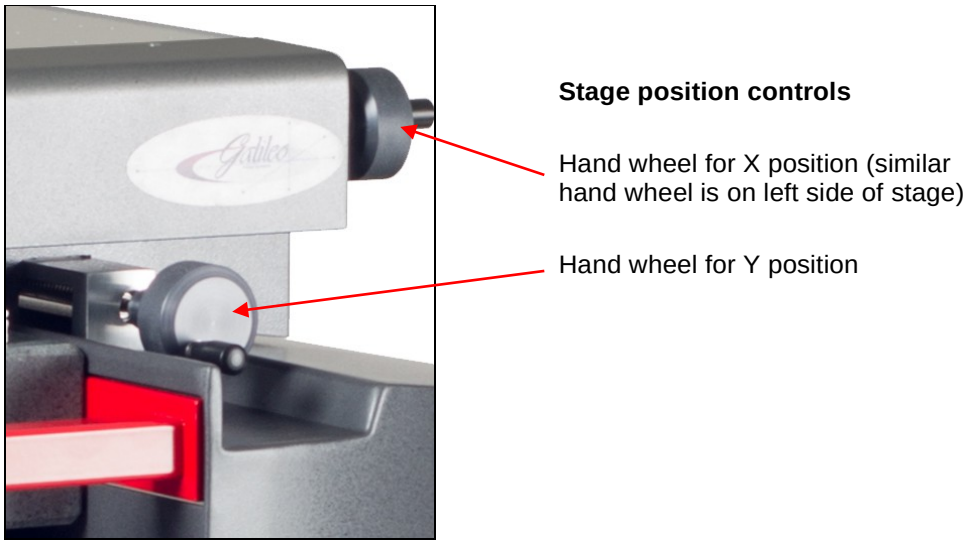
2.2 Component Description

1) **System Computer.** Runs MetLogix M3 software under Windows 7 professional. The computer can be an all-in-one touch PC with an integral 21.5" touch-screen, or a desktop PC mounted in the pedestal with a separate 23.5" touch-screen monitor, as ordered. The PC is connected to the system's video camera via a first USB cable and to the system's M3 controller via a second USB cable. Operator inputs can be via the PC's touch-screen or a wireless keyboard and wireless mouse. The computer 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. The system's wireless keyboard and a wireless mouse are used for file operations. With the optional M3 DXF/FOV option pack, DXF CAD files can be imported over a network and be automatically compared to actual measurements.

2) **MetLogix M3 Control Unit.** Located in machine pedestal. Interfaces the system PC to the metrology unit. Reads liner encoders and controls lighting.

3) **Metrology System Base.** Massive granite for stability plus cosmetic shroud.

4) **X-Y Stage.** Made from precision machined aluminum. Surface mounting holes allow customer-designed fixtures for part support. X-Y travel is 350 x 350 mm (14" x 14") for the MV350 and 450 x 350 mm (18" x 14") for the MV450. The X and Y positions are set by hand wheels as illustrated.



5) **Z-Column.** Supports video probe and ring light, which can be a fixed ring light or Dark Field Quad (QDF) ring light on a motorized Z-track. Z-height adjustment is 200 mm (8"). The Z position is motorized. Z control is by means of a speed toggle switch and a proportional speed control switch, as illustrated.

6) **Optical Probe Assembly.** Includes a 1/3" color CCD camera, 1024 x 768 pixels, with a USB 2.0 digital interface. Camera optics can be a manually set 6.5:1 zoom lens, or fixed telecentric optics, as ordered. Nominal telecentric magnifications are 0.30X, 0.50X, 0.80X, 1.0X, 2.0X or 4.0X. An optional 0.5X auxiliary lens for the zoom optics can increase the field of view while decreasing magnification. Optional 1.5X and 2.0X auxiliary lenses for the zoom optics can increase magnification while reducing the field of view. The video camera captures the part image for display and video edge detection (VED). Focus is set by adjusting the Z-height of the optical probe assembly over the surface to be analyzed so as to produce the sharpest image on the monitor. The settings of the video camera are preset at the factory and should not be modified.

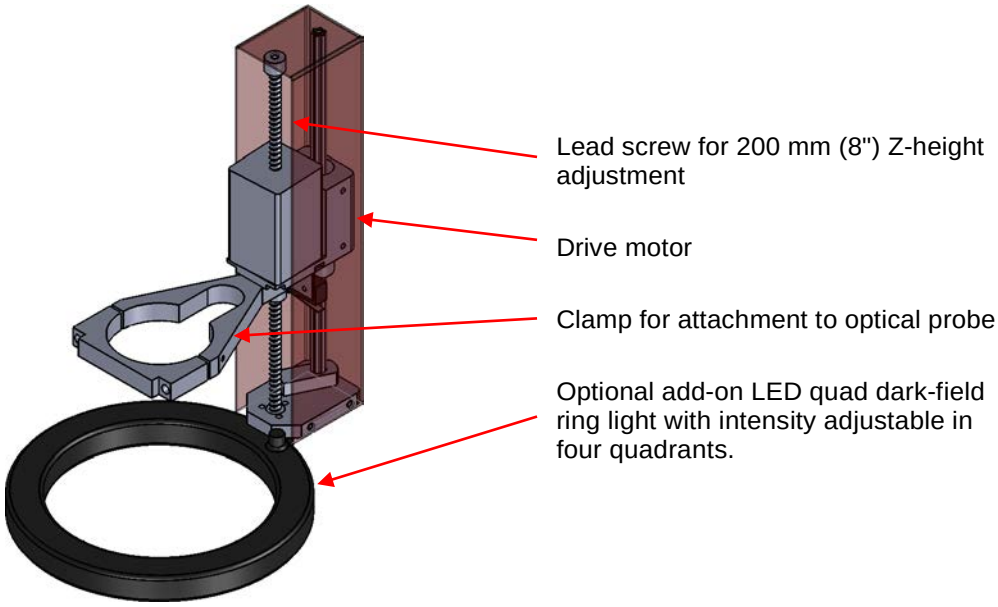
Speed toggle switch for Z height

Top position = high speed for coarse position
Center position = normal speed
Bottom position = slow speed for fine control

Proportion speed control switch for Z height

Top position = high speed upward
Center position = no motion up or down
Bottom position = high speed downward

7) Surface Illumination. Provided by ring lighting at the base of the optical probe. The standard ring light is fixed to the optical probe and provides even illumination from all directions. The light source can be LEDs in the ring or a 150W quartz-halogen lamp with fiber-optic delivery, as ordered. An optional quad bright-field LED ring light alternative allows LED intensity to be individually adjusted in four quadrants. An optional add-on LED quad dark-field (QDF) ring light can fit around the standard LED ring light. It allows LED intensity to be individually adjusted in four quadrants. It can be manually be adjusted in height by 100 mm (4”). Intensity control of all lighting alternatives is via M3 software for repeatable illumination.



8) Coaxial Illumination. Provides surface illumination along the optical axis of the camera. Achieved by applying light from the side via a beam-splitting mirror at the base of the optical probe. The light source can be LEDs or a 150W quartz-halogen lamp with fiber-optic delivery, as ordered. Intensity control of both lighting alternatives is via M3 software.

9) Silhouette Illumination. Provided by a sub-stage light. The light source can be LEDs in the sub-stage light or a 150W quartz-halogen lamp with fiber-optic delivery, as ordered. Intensity control of both lighting alternatives is via M3 software.

10) **Machine Pedestal.** Standard with MV350 /d MV450 systems. Supports metrology unit with granite base. Houses M3 control unit, power supplies, and quartz-halogen lamp housings (non-LED systems). Pedestal dimensions are 79 x 93 x 119 cm (31.0” x 36.5” x 47.0”).

11) **Anthro Cart.** Standard with MV350 / MV450 systems. Supports all-in-one PC with 21.5" touch-screen monitor or 23.5" touch-screen monitor for desktop PC, as ordered , plus wireless keyboard and wireless mouse. Height of cart is adjustable by 25 cm (10”) so that the system can be operated from a standing or sitting position. Slots in base allow insertion of auxiliary trays.

2.3 Environmental Considerations

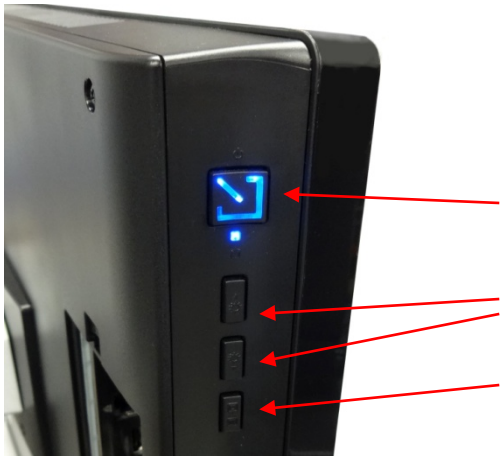
Starrett Vision Metrology Systems are factory calibrated under the standard laboratory environmental conditions shown below:

Specification	Requirement
Ambient Temperature	68°F ± 1°F (20°C ± 0.5°C)
Humidity	40-60% RH
Temperature rate of change	1°F (0.5°C) 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. Also consider material characteristics, such as coefficients of thermal expansion of the parts under inspection. Numerical compensation may be required when measuring parts under conditions different from those controlling the stated dimensional specifications for these parts.

2.1 System On/Off Controls

MV350 and MV0 systems are powered by three “brick” type AC adapters: one for the all-in-one touch-screen PC, one for the M3 controller, and one for the illumination controller. These adapters are normally plugged in a switchable outlet strip, which is located inside the machine pedestal and serves as the system’s master on/off switch. The all-in-one PC also has its own on/off switch, as illustrated below.



Note: These are typical controls of an all-in-one PC. Actual controls may change with the brand of PC.

On-Off switch in upper left of all-in-one PC. Before removing power, close all programs and shut down PC using the Windows “Shut down” button.

Monitor brightness controls

Selector switch for external monitor or LCD projector

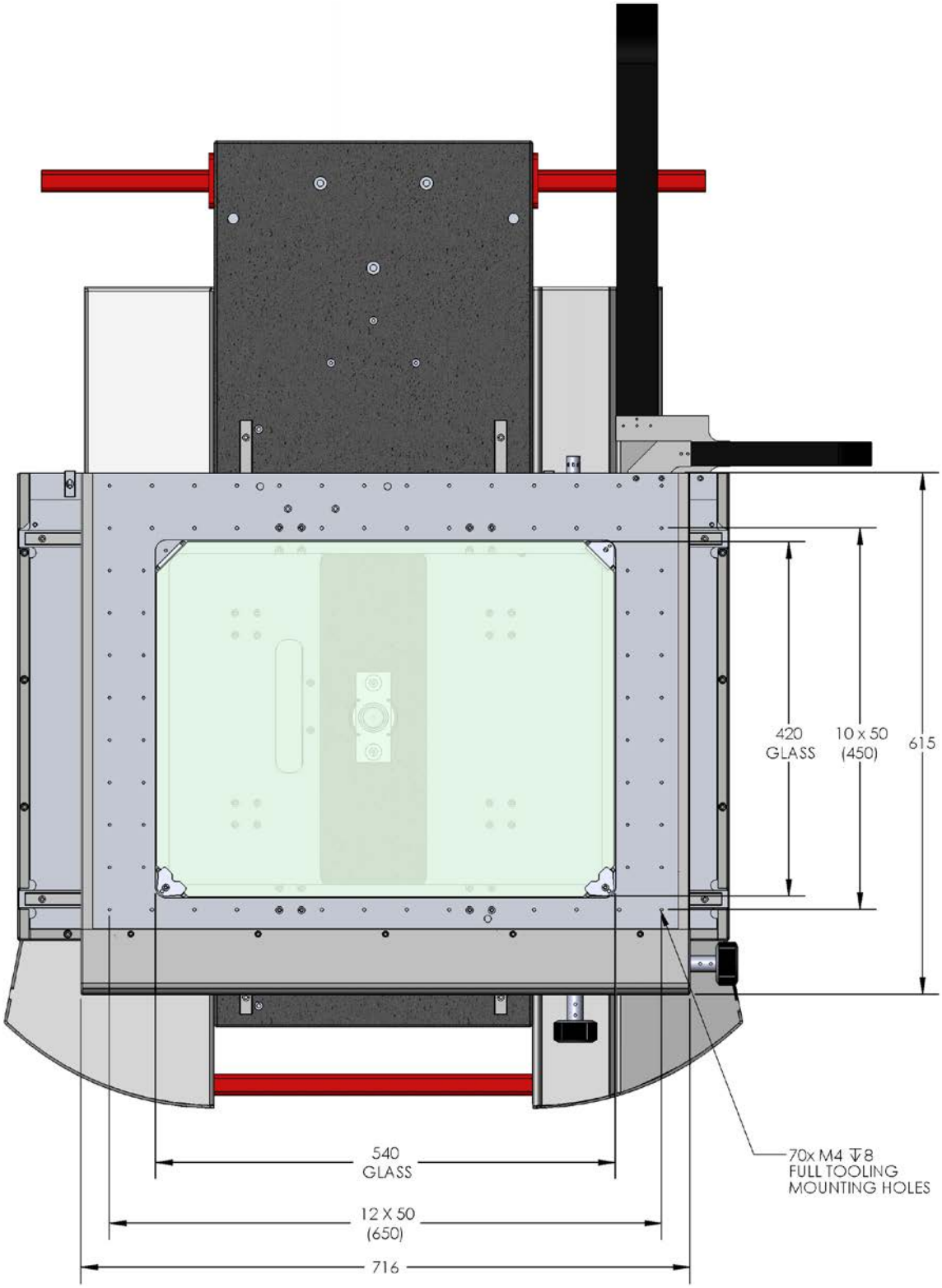
⚠	Before removing power, first close all computer files and applications, and then shut down the computer using the Windows “Shut down” button. Otherwise open computer data files could be corrupted by the sudden loss of power.

2.2 Safety Considerations

General Safety 	MV350 / MV450 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  	MV350 /d MV450 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 (if used). 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. Use the provided red safety bars to lift. • 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.

2.3 Stage Tooling Diagram

The Stage Tooling Plate allows attachment of customer-designed fixtures for part support. Please refer to the following diagrams for bolt-hole placement and size.



MV350 350 x 350 mm (14” x 14”) Stage Tooling Plate Diagram

3. INSTALLATION

3.1 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 MV350 / MV450 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).

The section below will be of help when a professional installer is not available.

3.2 Required Installation Tools

MV350 / MV450 vision metrology systems are carefully secured in a custom crate for stability and protection during shipment. Exercise care in handling the shipping crate, as excessive force or shock may damage its delicate contents. The following items are typically required to uncrate and install the metrology system:

1. Phillips screwdriver
2. Battery powered drill (Phillips bit recommended)
3. Standard slotted screwdriver
4. Small slotted screwdriver for cable connections
5. Industrial level (2 recommended)
6. Hex wrenches: metric set, 6 mm and smaller
7. Needle nose pliers (6" long)
8. 6" crescent wrench (2 recommended)
9. Black cable ties

3.3 Uncrating

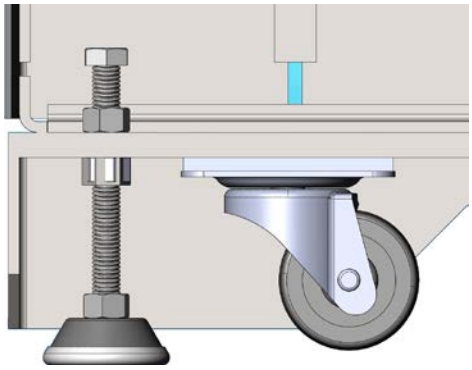
Remove the screws on the top of the crate and carefully remove the top. Remove one of the side panels for access to the contents. Remove and unpack all components. Verify that the contents match the packing checklist included in the documentation packet. Once the presence of all items has been verified, follow the assembly procedures below.

3.4 Placement of MV350 / MAV450 Pedestal

The pedestal must be leveled before the metrology unit is placed on top. Leave sufficient clearance in the back and on the sides to access the back of the workstation and metrology unit. A minimum clearance of 30 cm (12”) is recommended on both sides and in the back for installation and maintenance. This is in addition to the 30 cm required for travel of the cable track in back of the metrology unit.

3.5 Leveling of MV350 / MV450 Pedestal

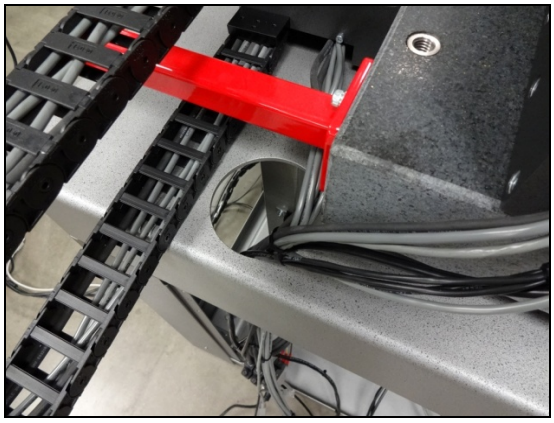
The pedestal includes a swiveling wheel on all four corners, plus an adjustable bolt which locks the pedestal in place and provides limited height adjustment. To lock the pedestal in place and adjust height, first turn the lock-nut on the bolt counterclockwise to its upper position. Then use a wrench to rotate the bolt clockwise to achieve the desired corner height. When done, rotate the lock-nut clockwise to prevent the bolt from further rotation. Once the pedestal has been leveled, carefully lift the metrology unit onto it.



Pedestal leveling mechanism

3.6 Lifting the Metrology Unit

Red carrying hand in front of MV350



Red carrying handle on side of MV350

MV350 / MV450 metrology units include a granite base and are very heavy. They come with permanently mounted red carrying handles to facilitate lifting and positioning. They can be lifted by four strong men: one each for the right and left handles, and two for the front handle.

3.7 Removing Shipping Retainers

MV vision metrology systems (and other Starrett metrology systems) use metal lock-down tabs to prevent movement of critical motion components during shipment. These are intended to be removed once the equipment has been placed in its final position. Look for the lock-down metal tabs and permanently remove these.

3.8 Electrical Power Considerations

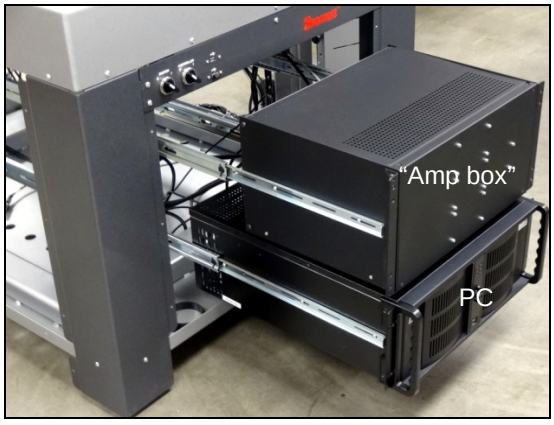
Brick-type power adapters

MV350 / 450 systems can be powered by up to three “brick” type AC adapters: one for the all-in-one touch-screen PC, one for the M3 controller, and one for the illumination controller. The AC adapters as well as the desktop PC (of ordered) all accept 100/240 Vac power for worldwide use. They are normally plugged in a switchable outlet strip, which serves as the master power distribution point and is located inside the machine pedestal.

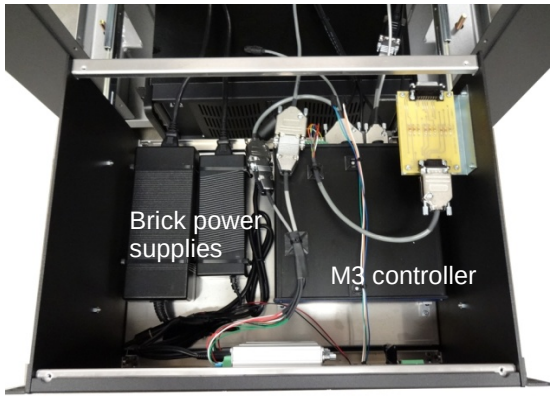
The pedestal is wired so that there is a front panel master power switch for the system and a second power switch for the M3 controller. Use this second switch to reset and initialize the M3 controller when needed. Turning on the master power switch will automatically turn on the computer. Turning off the master power switch will turn off the computer. Before doing so, shut down the computer under Windows to close any open files.

	WARNING: Make sure that the main power plug is connected to a properly rated and grounded receptacle. Do not energize power cables until the entire system has been properly set up per these instructions. Power goes on last.

3.9 Wiring of Electronics in MV350 / MV450 Pedestal

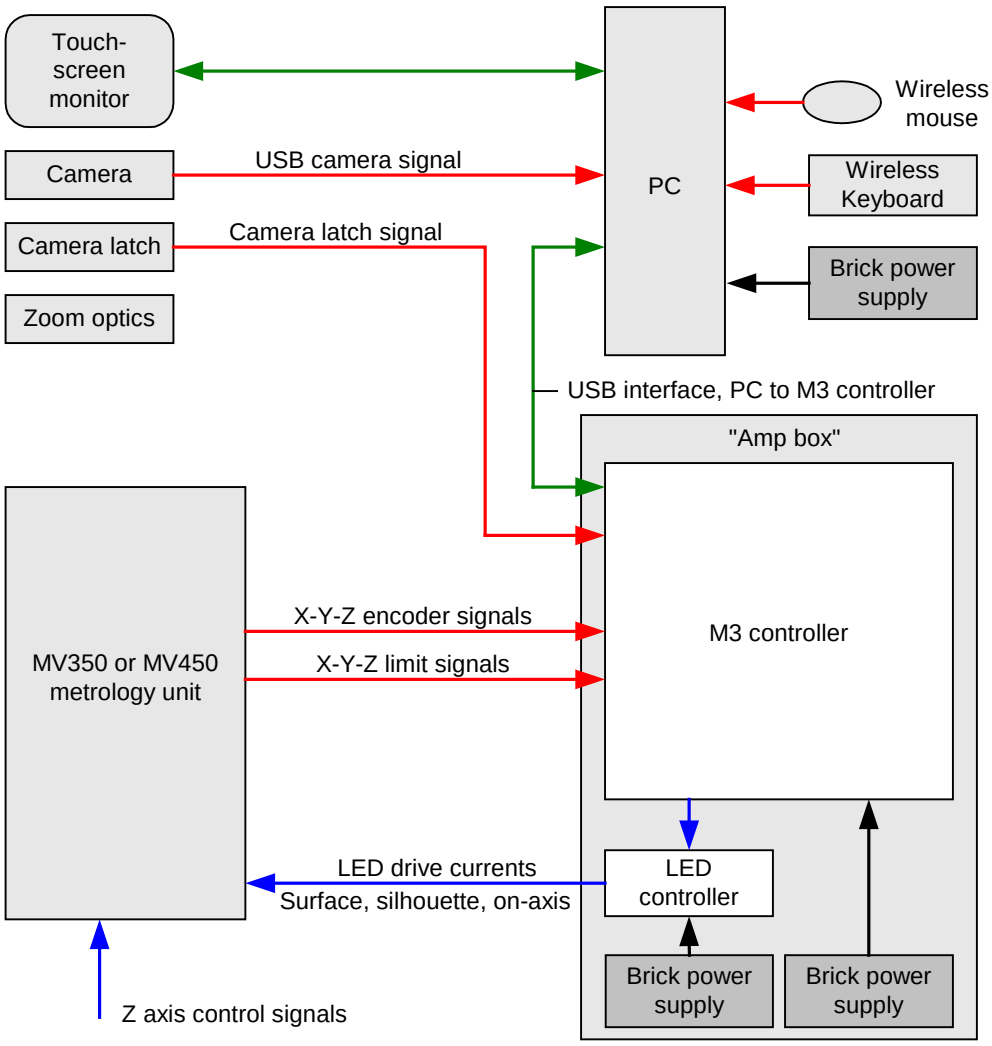


Pulled out PC (if ordered) and “Amp box”



“Amp box” with top cover removed

1. After the system has been placed on its pedestal, route the cables from the metrology unit through the hole in the pedestal as shown in the photo “Red carrying handle on side of AV350”’ on this same page.
2. For easier wiring access, pull out the PC and “Amp box” from the pedestal (if included), and remove the top cover from the “Amp box”. Note that manual vision metrology systems may not use an "Amp box".
3. With power still removed from the system, start to make electrical connections. Please refer to the diagram below.



Electrical block diagram

	INSTALLATION HINT: To facilitate interconnection, the ends of most cables and the matching connectors on the equipment are labeled. Secure cables with cable ties following installation as appropriate.

4. MEASUREMENT STRATEGY

MV350 / MV450 vision metrology systems can be operated with 6.5:1 zoom optics with continuously adjustable magnification from 0.7X to 4.5X or with any of 6 telecentric fixed-focus lenses with magnification from 0.30X to 4.0X or. Magnification is the image size at the camera CCD detector place divided by the object size. Since the CCD size is fixed, each magnification has a corresponding field of view (FOV), which is the CCD size divided by magnification. The higher the magnification, the higher the resolution but the smaller the field of view.

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

4.1 Zoom Optics Measurement Strategy

The 6.5:1 zoom optics allow magnification to be continuously adjusted from 0.7X to 4.5X. While the zoom optics can provide the same field of view as the four higher magnification telecentric lenses, they do not offer the same low optical distortion that is required for accurate field-of-view measurements across the entire field of view. 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 field of view, 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 field of view. 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.

4.2 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, and the M3 software will seamlessly integrate FOV measurements with encoder readings from stage motion.

4.3 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.

4.4 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.

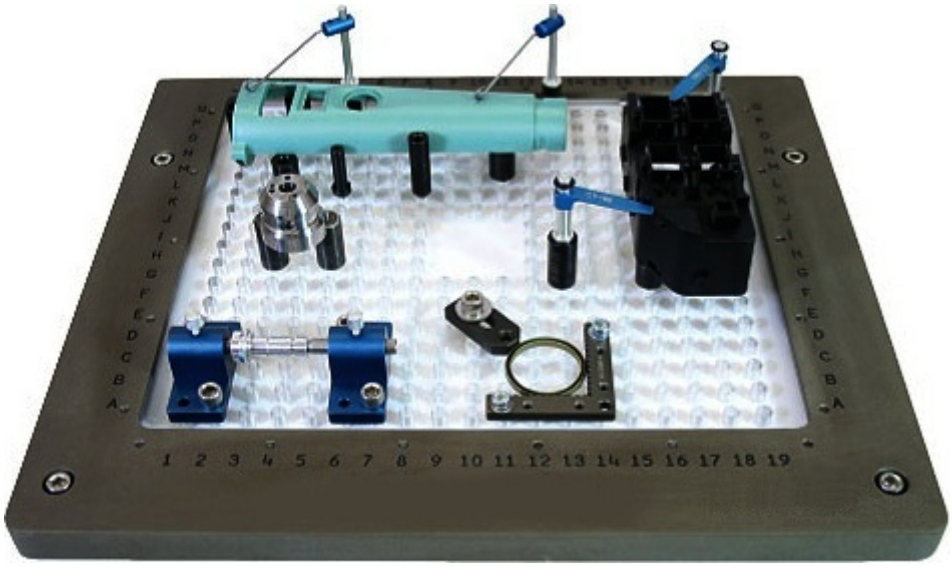
4.5 Focus Strategy

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.

4.6 Parts Fixturing

The part must be fixtured securely to prevent part movement during measurement. Options are available from Starrett Kinemetric for off-the-shelf, semi-custom or custom fixturing. Please contact Starrett Kinemetric sales with your requirements.

Aligning the part's X or Y axis to the stage will improve dimensional measurements. If the part is off-axis from the stage, X-Y-Z measurements will not correlate as well with true part dimensions. Orientation error can also be removed by creating a reference frame based on the part before creating measurements. Please see the M3 Software Manual for details on the skew function.



Example of Custom Fixturing

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4.7 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.

5. SYSTEM MAINTENANCE

MV350 / MV450 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.

5.1 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.

5.2 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..

5.3 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.

5.3.1 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.

5.3.2 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.

5.3.3 Zoom Optics Squareness

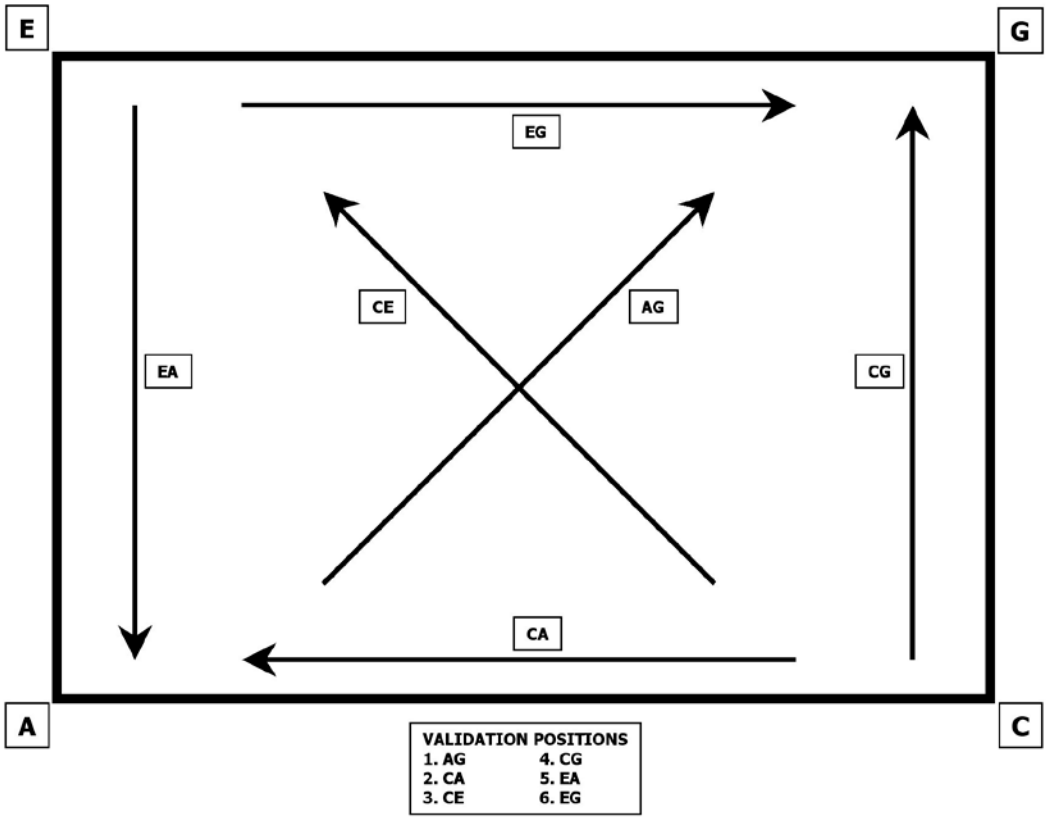
Squareness refers to the alignment of the camera relative to the motion of the metrology stage. If the camera is misaligned (out of square), an image will appear to drift diagonally across the video image as the stage position is moved along one axis.

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.

5.4 Calibration Verification

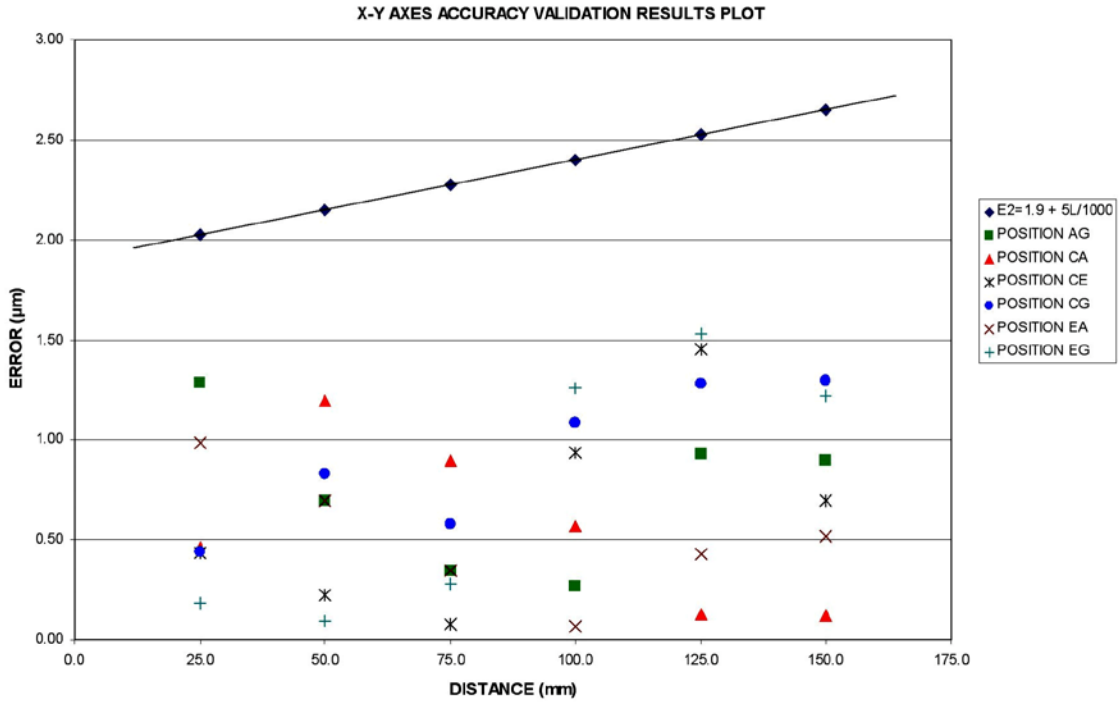
Calibration should be verified periodically depending on user requirements and systems usage, and should be at least monthly. A calibration verification standard artifact is available from Starrett authorized distributors or directly from the Starrett service department. Calibration should also be verified 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

5.5 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.

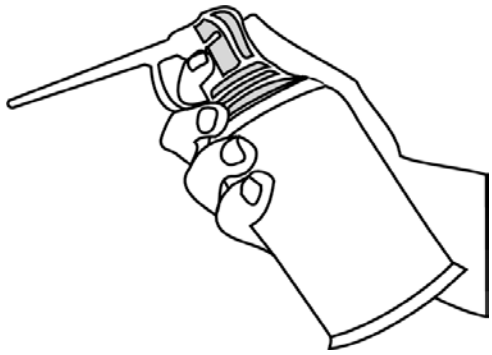
5.5.1 Cleaning External Surfaces

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.

5.5.2 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.

5.5.3 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.

6. 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.

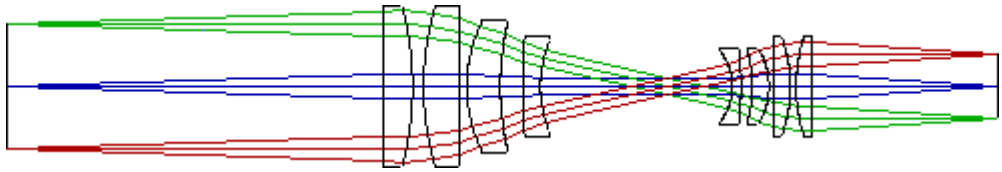
Resolution The least significant digit to which a physical quantity can be read. High resolution does not imply high accuracy.

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.