



MVR200 and MVR300 Manual Video Metrology Systems User Guide



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1 About This Guide

1.1 Purpose

This guide provides instructions on how to install, operate and maintain the MVR200 and MVR300 manual digital video systems. This guide also provides information on the various options and features available with the system.

Terminology

Throughout this document, unless otherwise stated, the term MVR refers to both the MVR200 and MVR300 systems.

1.2 Scope

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

1.3 Audience

This guide is intended for end-user customers, SKE Technical Services specialists, and Authorized Service Partners.

1.4 Prerequisites

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

1.5 Conventions

Information that Requires Special Attention

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

A warning looks like this:

WARNING

Warning information is printed in a box. Warnings direct your attention to operating or maintenance procedures or practices that must be followed correctly to prevent personal injury, loss of life and, possible, hardware or software damage.

A caution looks like this:

Caution

Caution information is printed in a box. Cautions provide information that helps to prevent accidental hardware or software damage.

A note looks like this:

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

1.6 Warranty

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

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

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

1.7 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.

1.8 Copyright and Trademark Information

MVR200™ and MVR300™ are trademarks of the L.S. Starrett Company. M3™ is a trademark of MetLogix, Inc. Windows® is a registered trademark of Microsoft Corporation.

1.9 Related Production Information

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

MetLogix M3 Video and FOV Inspection Software User's Guide

This guide provides detailed information on operating the M3 software that is included with MVR systems.

AVR and MVR Video Metrology Series Systems Unpacking Read Me First Instructions

These instructions provide the unpacking instructions for the MVR200 and MVR300 systems.

2 Environmental, Regulatory, and Safety Information

This section provides the regulatory, environmental, and safety information for the MVR systems.

2.1 Environmental Conditions

Operating Conditions

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 in the previous table, the system should be recalibrated under the expected conditions. Users should also consider the material characteristics of the parts under inspection, in particular coefficients of thermal expansion. Numerical compensation might be required when measuring parts under conditions different from those controlling the stated dimensional specifications for these parts.

Factory Calibration Conditions

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 ± 5°F)
Humidity	40-60% RH
Temperature rate of change	0.5°C (1°F) per hour

2.2 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

Standard	Description
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

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

2.3 Safety Considerations**General Safety**

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

Electrical Safety

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

- Ensure that the power receptacles for the AC adapters are properly grounded 3-prong polarized 100-240VAC for use in North America or appropriate safety-rated receptacles for use outside of North America.

- Do not operate the systems with housings open except for service by a factory trained technician.
- Keep liquids away from the systems, and do not operate the equipment in excessively humid conditions, as water can cause short circuits.
- Keep metal filings away from the systems, as such debris can cause short circuits.
- Do not operate the equipment around volatile or flammable solvents, as local electrical heating could cause ignition.
- Disconnect power, or do not plug in the power cord, if hazardous conditions exist such as a damaged or frayed power cord, a damaged or improperly grounded power receptacle, equipment exposure to liquid spills or excessive moisture, or impact damage. Have the system inspected by authorized personnel before operating.

There are no fuses or user-serviceable items in the systems. Systems should only be opened by a factory-trained service technician.

Mechanical Safety

- MVR systems are heavy. To avoid possible back injury, use multiple people to lift. Bend your knees, not your back.
- Only manually lift MVR systems by the two red carrying handles and shipping lift bar. For more information on lifting the system, refer to “Removing Shipping Retainers” later in this guide.

3 The MVR200 and MVR300 Systems

This section provides the following information:

- An overview of the MVR systems
- A description of the features and capabilities of the MVR systems
- A description of the configuration options
- A description of the major components of the MVR systems

3.1 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 (7.9 x 3.9 x 7.9 inch) of X-Y-Z travel, and the MVR300 with 300 x 200 x 200 mm (11.8 x 7.9 x 7.9 inch) of X-Y-Z travel. MVR 300 is capable of measuring parts with a length up to 11.8 inches (300mm).

3.2 Features and Capabilities

The MVR systems include the following features and capabilities:

- 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 inches 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 24-inch monitor and a system PC that runs MetLogix M3 FOV software under Windows® 11 Professional.

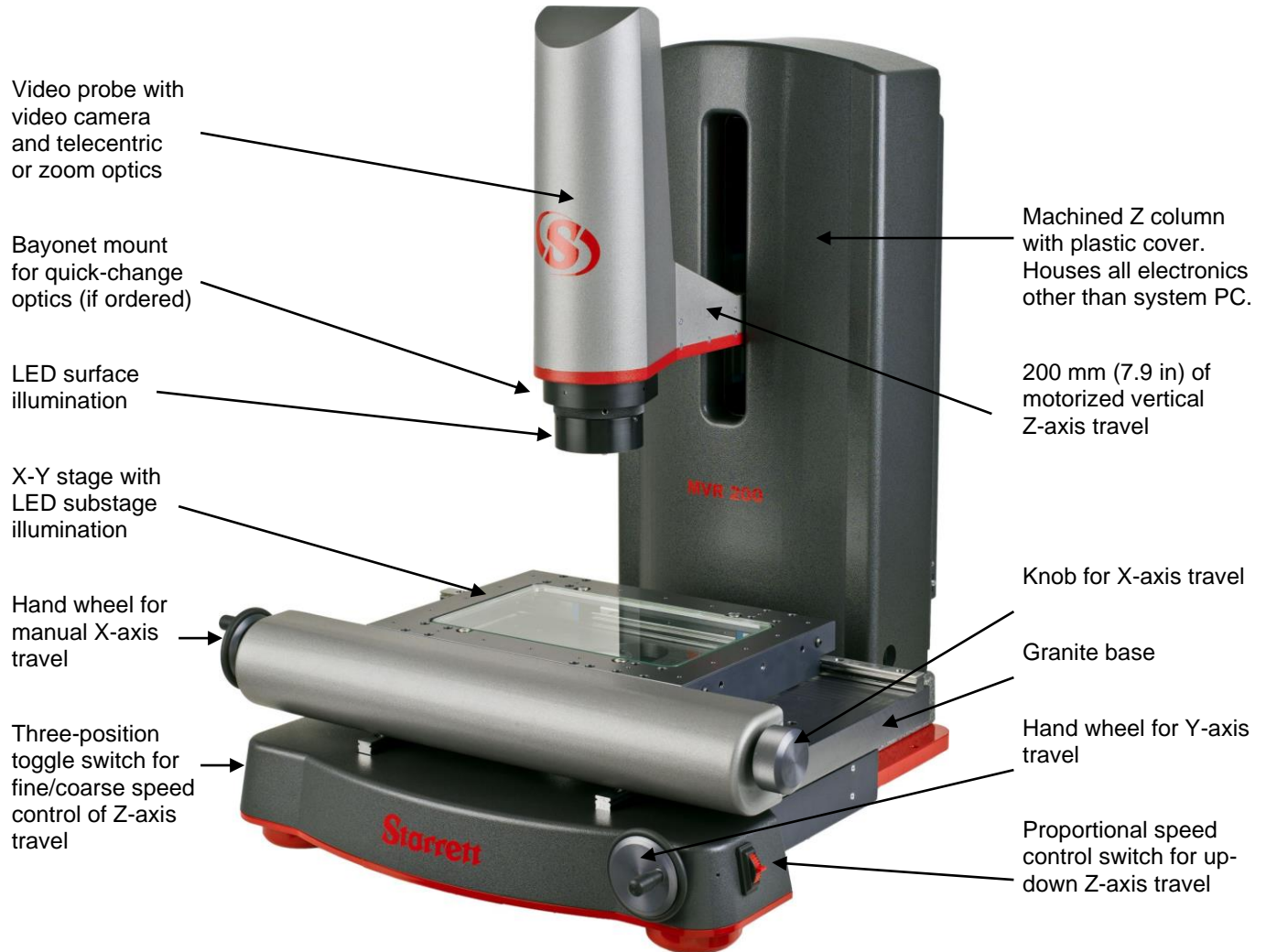
3.3 MVR Configurations and Options

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.

System	Options
MVR200 and MVR300 Basic	<ul style="list-style-type: none"> 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.
MVR200 FOV and MVR300 FOV	<ul style="list-style-type: none"> 2 Mpixel color video camera 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)
Options	<ul style="list-style-type: none"> Auxiliary lenses for the zoom optics (0.5X, 1.5X, 2.0X) Ergonomic workstation
Accessories	<ul style="list-style-type: none"> Calibration standards Calibration grids Magnification checkers NIST-traceable calibration standards <p>For more information on available accessories, refer to "Spare Parts and Accessories" later in Section 8.</p>

3.4 MVR200 and MVR300 System Components

The following information describes the key components of the MVR systems.



3.4.1 X-Y Stage

The MVR200 stage offers a measurement range of 200 x 100 x 200 millimeters (7.9 x 3.9 x 7.9 inches) of X-Y-Z travel. The MVR300 offers a measurement range of 300 x 200 x 200 millimeters (11.8 x 7.9 x 7.9 inches) for X-Y-Z travel. The stage is made from a granite base. Stage motion includes manual X and Y axis and motorized Z axis control.

3.4.2 Motorized Z Column

A motorized Z column provides for 7.9-inches (200mm) of Z-axis travel. A three-position toggle switch allows for fine/coarse speed control of Z-axis travel.

Dedicated zoom optics or a quick-change bayonet lens mount which accepts interchangeable zoom optics or telecentric lenses for micron-level resolution.

3.4.3 Operator Controls and Interfaces

The following information provides the controls and interfaces of the MVR systems.

System PC

The MVR systems include a small form factor PC where the MetLogix M3 software is preinstalled and controlled.

Touch-screen monitor

The 24-inch touch screen monitor is used to control the M3 software. The monitor displays a live video image of the part in addition to software measurement tools and digital readings. The image of the part can be resized using pan and zoom, and measurements can be taken by simply tapping a feature on the screen.

Wireless keyboard and mouse

The wireless keyboard and mouse are used to input data to the system PC.

3.4.4 MetLogix M3 Software

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

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

live error whisker display for violations of the original DXF tolerance zones. DXF/FOV option pack features include:

- Custom DXF crosshair
- Create feature-based video overlays
- Import DXF overlay
- Export features to DXF
- Pattern teach and recognition
- Live image “freeze”

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

3.4.5 Lens Options

MVR systems are available as fixed mount or with a bayonet fitting for quick optics changes. To maximize versatility, the system provides the capabilities for lens options including 6.5:1 zoom optics with auxiliary lenses from 0.5X, 1.5X, 2.0X and telecentric lens options from 4X to 0.30X.

3.4.6 Lighting Control

The MVR systems include LED-based lighting control. Light is emitted by ultra-bright LEDs mounted directly in the ring light, quad ring light, and collimated sub-stage light. The output of each light source is controlled through an LED controller and the M3 software. The following provides additional information the light source options.

Ring Light

Both zoom and telecentric lenses can include a ring light. The ring light illuminates objects from the top with even illumination from all sides. The following figure illustrates the ring light.



Figure 1. Ring Light

Quad Ring Light

The quad ring light enhances the capabilities of the ring light. The quad ring light provides a total of 96 ultra-bright LEDs in four quadrants. Light intensity for each quadrant can be adjusted using the M3 software. The height of the quad ring light is also adjustable. In combination, adjustments of height, direction and light intensity provide very flexible illumination for edge detection. The following figure illustrates the quad ring light.



Figure 2. Quad Right Light

3.4.7 Workstation

The MVR systems include the option for an ergonomic workstation and workstation extension. The following figure illustrates the workstation. Refer to “System Specifications” later in this document for detailed information.



Figure 3. MVR Workstation Option

4 System Specifications

This section provides the specifications for the various components of the MVR systems.

4.1 Performance Specifications

The following table provides the performance specification for the MVR systems.

Feature	MVR200	MVR300
Measurement Range, X-Y-Z	200 x 100 x 200 mm (7.9 x 3.9 x 7.9 in)	300 x 200 x 200 mm (11.8 x 7.9 x 7.9 in)
Reading Resolution, X-Y-Z	0.5 μ m (0.00002 inches)	
Reading Accuracy, X-Y-Z	1.9 μ m + 5L/1000 for X and Y, 2.5 μ m + 5L/1000 for Z	

4.2 Computer Hardware and Software Specifications

The following table provides the hardware and software specifications for the MVR systems.

Feature	Specification
Computer Hardware	PC with 16GB RAM and INTEL i5-1335U Processor
Computer Interfaces	Eight USB ports, SATA 3.0, dual M.2 slots, one M.2 E slot, HDMI 2.0b, DisplayPort, VGA.
Computer Display	24-inch touch screen monitor
Data Storage	250 GB hard disk
Operating System	Windows® 11 Professional
Application Software	MetLogix M3 metrology software and DXF/FOV option pack
Geometrical Constructs	2D geometries plus height

4.3 Hardware and Mechanical Specifications

The following table provides the hardware and mechanical specifications of the MVR systems.

Feature	MVR200	MVR300
Unit Dimensions, H x W x D	865 x 600 x 645 mm (34 x 23.7 x 25.4 in)	865 x 790 x 865 mm (34 x 31 x 34 in)
Stage Glass Size	260 x 160 mm (10.2 x 6.3 in)	368 x 268 mm (14.5 x 10.5 in)
Maximum Load Capacity	18kg (40 lbs.)	
Metrology Base	Granite	
Motion Control	Manual X and Y, motorized Z	
Operator Controls	Touchscreen monitor, wireless keyboard, wireless optical mouse	

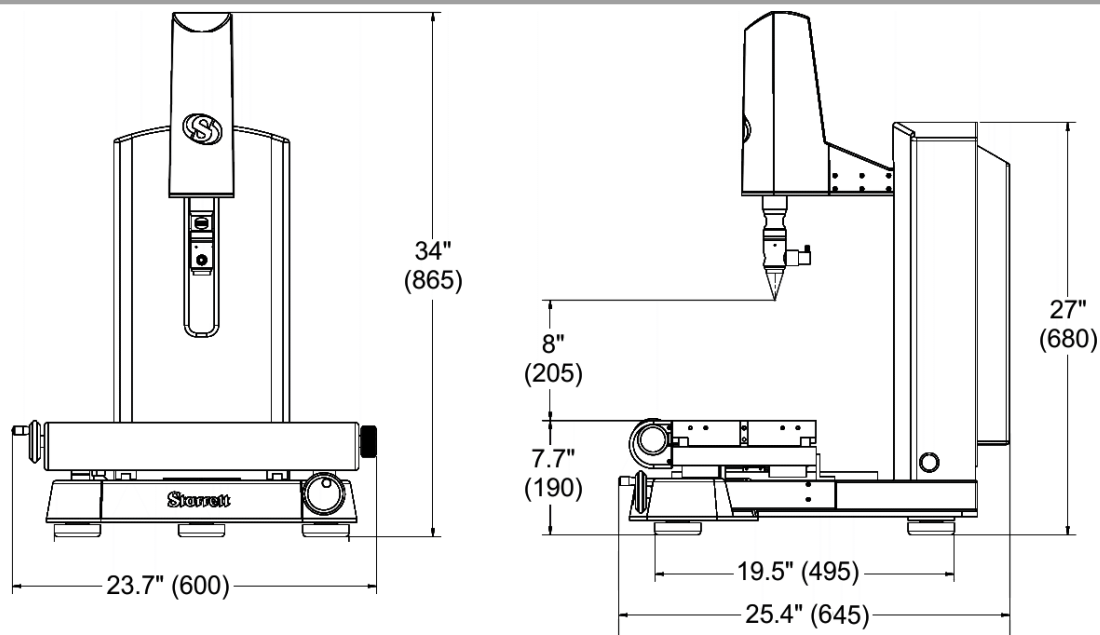


Figure 4. MVR200 Dimensions

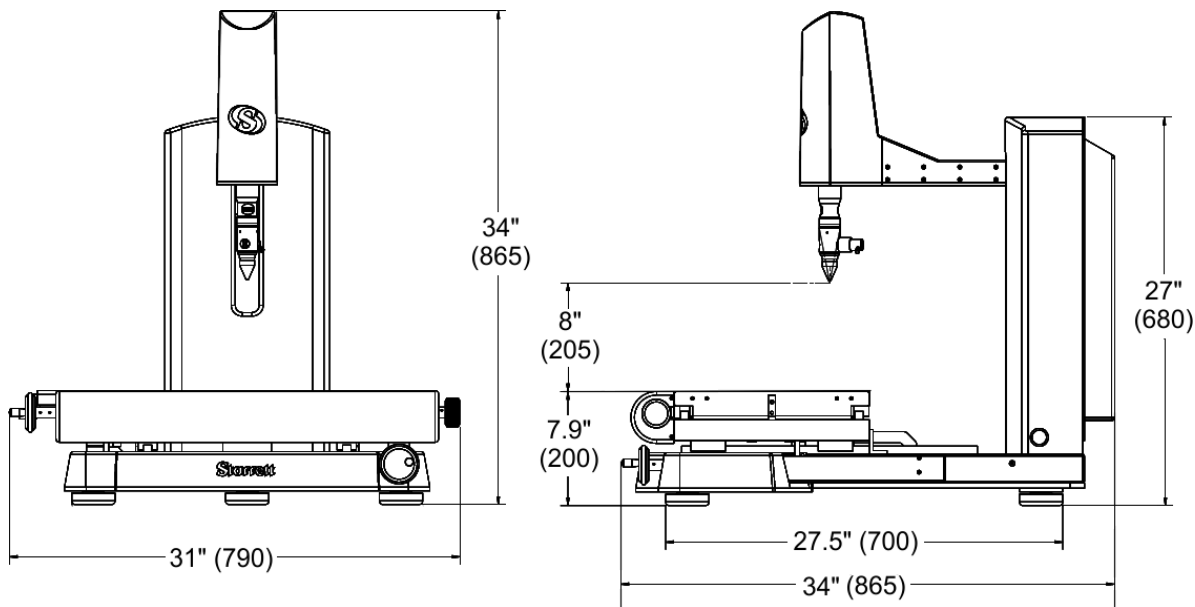


Figure 5. MVR300 Dimensions

4.4 Lighting Specifications

The following table provides the lighting specifications for the MVR systems.

Feature	Specification
Substage Illumination	LED illumination matched to camera optics
LED ring light	40 LED ring light
Quad ring light	<ul style="list-style-type: none"> 96 white LEDs in four quadrants whose intensity is individually adjustable with the M3 software 125 mm (5 inches) outside diameter, 100 mm (3.9 inches) inside diameter, 19 mm (0.75 inches) high

4.5 Electrical Specifications

MVR systems are powered by two “brick” type AC adapters. The following table provides the specifications of the AC adapters.

Feature	Specification
Metrology unit AC adapter	19.5 VDC output
System PC AC adapter	24 VDC output
Voltage requirement	100/240 VAC power for worldwide use
Maximum combined current draw	3.6A at 120 VAC 1.8A at 240 VAC

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.



Figure 6. Power Supplies

4.6 Optics Specifications

The following table provides the optic specifications for the MVR systems. Optics are mounted with a fixed mount or bayonet fitting for quick optics changes.

Camera

Feature	Specification
Camera Resolution	<ul style="list-style-type: none"> 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

Zoom Optics

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 inches)
Magnification on Monitor*	31X to 200X
Zoom Working Distance	88 mm
Available Auxiliary Lenses	0.5X, 1.5X, 2.0X

Telecentric Optics

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 in	14 mm 0.56 in	8.9 mm 0.35 in	7.1 mm 0.28 in	3.6 mm. 0.14 in	1.8 mm 0.07 in
Telecentric Working Dist.	110 mm					

4.7 Workstation Specifications

The following table provides the specifications for the workstation. The following figure provides the dimensions.

Feature	Specification
Workstation width	27 inches (68.5 cm)
Workstation extension width	26.65 inches (67.6 cm)
Workstation and extension width	60.62 inches (153.9 cm)
Workstation depth	28.07 inches (71.2 cm)
Workstation height	33.87 inches (86 cm)

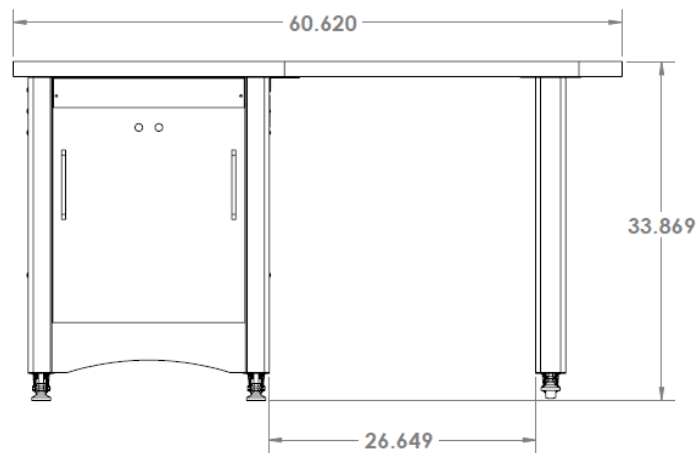


Figure 7. Workstation Dimensions

5 Installation and Setup

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

- Planning the placement of the system
- Moving the system
- Unpacking the system
- Installing the system
- Removing Shipping Retainers
- Setting up the system

5.1 Planning the Placement of the Equipment

When planning the placement of the MVR systems, refer to the following recommendations:

- Ensure a clean operating environment to minimize the accumulation of dirt on the optics and on precision mechanical parts, such as lead screws and encoder scales.
- Ensure the planned installation location has the proper electrical requirements. Refer to “Electrical Specifications” earlier in this document for detailed information.
- Select an installation location where the temperature can be controlled to within $20^{\circ}\text{C} \pm 0.5^{\circ}\text{C}$ ($68^{\circ}\text{F} \pm 5^{\circ}\text{F}$), which is the calibration temperature of the system.
- It is recommended (but not essential) the system be placed on a level work surface using a bubble level for verification.
 - MVR systems are designed to be installed on a benchtop at a height of approximately 85 centimeters (33.5 inches), which is the height of the workstation offered by SKE.
- Allow 60 centimeters (24 inches) to right or left side of the metrology unit to position the monitor.
- Allow additional clearance of 30 centimeters (12 inches) on both sides is recommended for general access.
- Allow a minimum of 5 centimeters (2 inches) behind the unit for air flow, as the electronics compartment only uses convective air cooling.
- Allow 50 centimeters (20 inches) of space at the back of the unit to completely open the hinged door for service access. If necessary, the metrology unit can be moved as needed for service.

Refer to “System Specifications” earlier in this document for the detailed information on the dimensions of the system.

5.2 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.

5.3 Uncrating the Equipment

Detailed instructions for uncrating the MVR system are available in the ***AVR and MVR Video Metrology Series Systems Unpacking Read Me First Instructions*** shipped with the system.

Tool Requirements

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

- Battery powered drill with Phillips drill bit
- Crescent wrench
- Bubble level (optional, to level workbench or workstation).
- Other common hand tools.

Procedure

To uncrate the MVR system, refer to the following figure and perform the following steps:

1. Remove the screws on the top of the crate and carefully remove the top.
2. Remove one of the side panels for access to the contents.
3. Remove and unpack all components.
4. Verify that the contents match the packing checklist included in the documentation packet.



Figure 8. Removing Screws from the Shipping Container

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MVR systems are shipped with multiple mechanisms to prevent movement during shipment. The following information describes the various retainers. Refer to the following figures for locations of these retainers.

Carrying Handles

To remove the carrying handles, refer to the following figure and perform the following steps:

1. Locate the two red carrying handles near the back of the base. The carrying handles can be removed or be left on the system following installation to facilitate possible later lifting.
2. Locate the 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. The bar is normally removed once the system is installed.
3. Slide the bar out to remove it from the system.
4. Remove any tape and packing materials that might have been added for shipment.

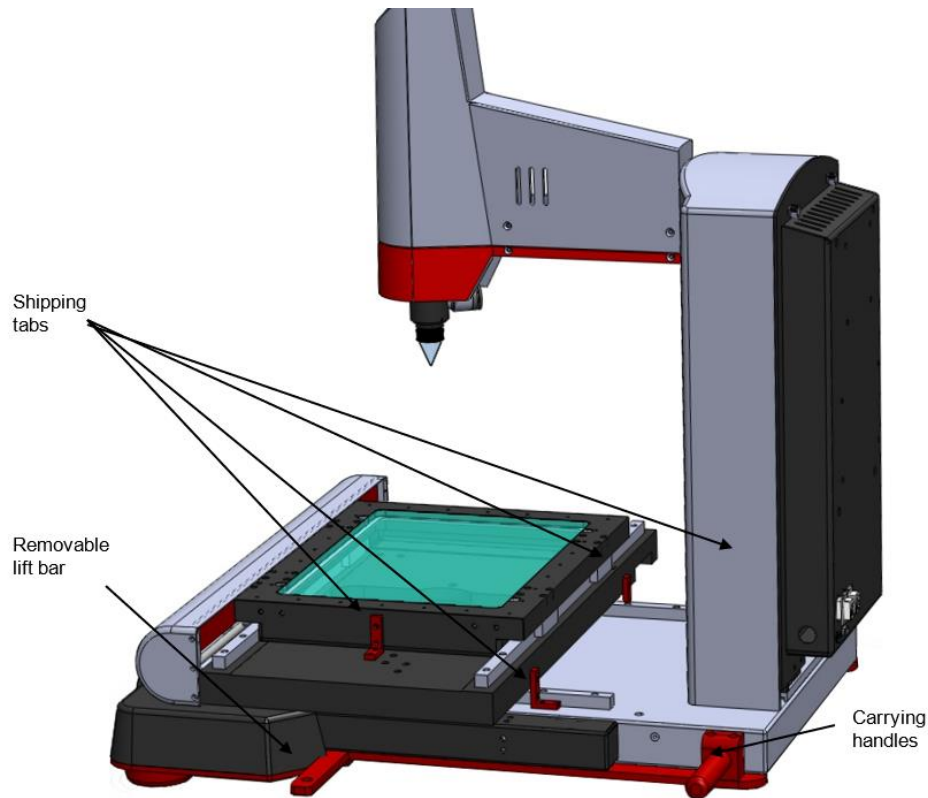


Figure 9. Location of Red Retainer Tabs, Lifting Handles, and Slider Bar

Shipping Tabs

To remove the shipping tabs, perform the following steps:

1. Locate the four red tabs that are securing the stage. There are two tabs on each side of the stage. Refer to the following figure and the previous figure.

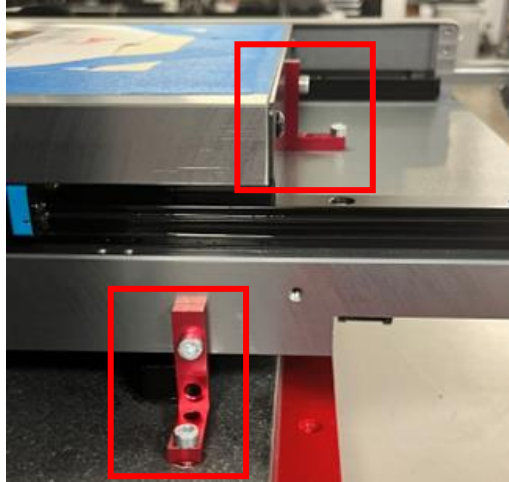


Figure 10. Stage Shipping Tabs

2. Using a metric hex wrench, remove the two M5 socket head cap screws that secure each tab.
3. From the rear of the system, using a Phillips screwdriver, remove the two M4x10 screws and washers from the top of the hinged door to access the electronics of the system.



Figure 11. Accessing the MVR Rear Panel

4. Locate the two red tabs by referring to the following figure.
5. Using a metric hex wrench, remove the two M5 socket head cap screws that secure each tab. Refer to the following figure.

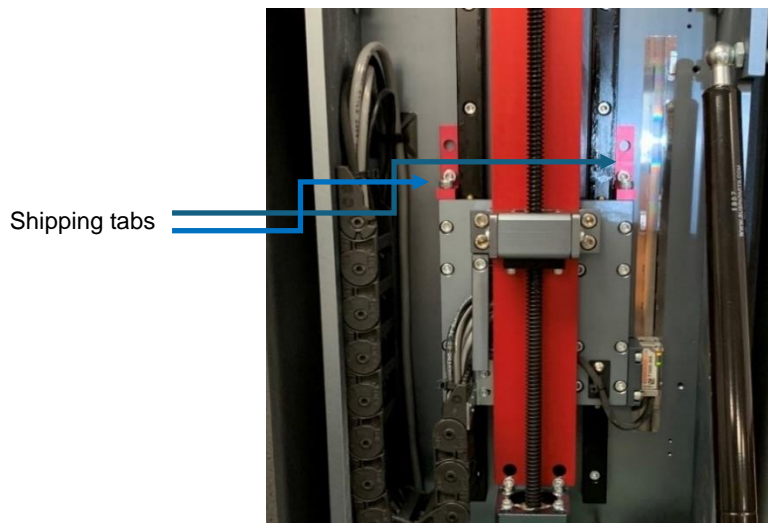


Figure 12. Rear Panel Shipping Tab Locations

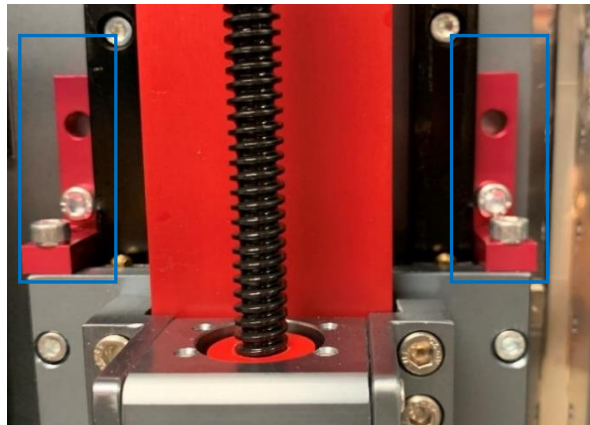


Figure 13. Removing the Shipping Tabs

6. Close the hinged door and reattach the washers and M4 screws.

5.5 Setting Up the System

To set up the system, refer to the following figures and perform the following steps:

1. Locate the I/O panel on the rear of the MVR system. The rear panel includes a sticker so that cabling locations can be easily identified. Refer to the following figure.
2. Connect the power cable to the connector marked “24V” on the I/O panel. This cable provides input from the power supply.
3. Connect the remaining end of the power cable to an appropriate power outlet.



Figure 14. MVR I/O Panel

4. Connect the USB cable to the USB connector marked “M3” on the I/O panel of the MVR metrology unit and the remaining end of the cable to the USB connector on the rear panel of the system PC. This cable supports the encoder signals for the M3 software. Refer to the following figure.
5. Connect an additional USB cable to the USB connector marked “Camera” on the I/O panel on the MVR system and the remaining end of the cable to the rear panel of the system PC. This cable supports the camera signal.

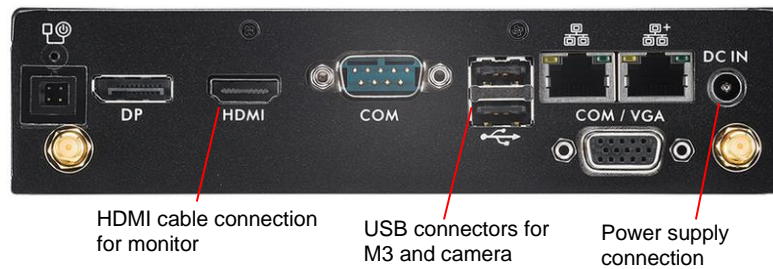


Figure 15. System PC Rear Panel

6. Connect the HDMI monitor cable to the HDMI port on the rear panel of the system PC.
7. Connect the power supply cable from the rear panel of the system PC to a power source.
8. On the front panel of the system PC, insert the dongle for the wireless keyboard and mouse. Refer to the following figure.

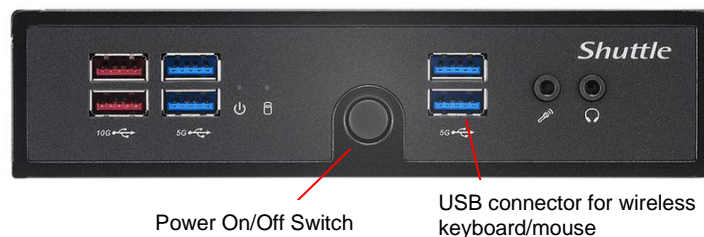


Figure 16. System PC Front Panel

5.6 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 half 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. Starrett offers ISO 17025 accredited calibrations. Calibration uses NIST-traceable glass grids and gage blocks. Calibration typically takes a half day for an MVR manual system.

On-site basic operator training is provided following calibration. This typically takes half day for an MVR manual system. Many customers choose to augment basic training with additional hands-on training, where new operators program actual parts of the type on which they will be working. Training is with the new equipment and is limited to one to three people, so that these can all get hands-on time. Starrett's objective is to create power users, who can then train other users when needed.

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 Kinematic 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).

Visit <http://www.ske-service.com> for more details and to request services.

5.6.1 Contacting Starrett Kinematic Technical Support

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

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

6 System Operations

This section provides information on the following operations for the MVR systems:

- Powering on the system
- Using the system controls
- Changing the optics
- Optimizing substage illumination
- Leveling the stage glass
- Fixturing parts

6.1 Powering On the System

Power Switches

MVR systems have two power switches. Refer to the previous figures.

- On/Off rocker switch on the side of the MVR system
- Power button on the front of the system PC

Caution

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

Procedure

To power on the system, perform the following steps:

1. Ensure all the cable connections on the rear of the system are correct. Refer to the previous section.
2. Press the Power On/Off switch on the side of the unit to the “I” position. Refer to the following figure.



Figure 17. MVR System Power On/Off Switch

3. Power on the mouse by moving the switch on the bottom of the mouse to the On

position.

4. Power on the keyboard by moving the switch on the top of the keyboard to the On position.
5. Power on the monitor.
6. Power on the system PC. Ensure that the system PC boots up properly.

6.2 Using the Systems Controls

The following table describes the operator controls for the MVR system. Refer to the following figures for the locations.

Control	Location	Function
Hand wheel with crank	Left side of system	X-axis motion
Toggle switch	Left side of system	Three-position switch for fine/coarse speed control of Z-axis travel.
Knob	Right side of system	X-axis motion. Attached to same shaft as hand wheel on left side of machine.
Speed control switch	Right side of system	Proportional speed control switch for up-down Z-axis travel.
Hand wheel with crank	Right side of system	Y-axis motion

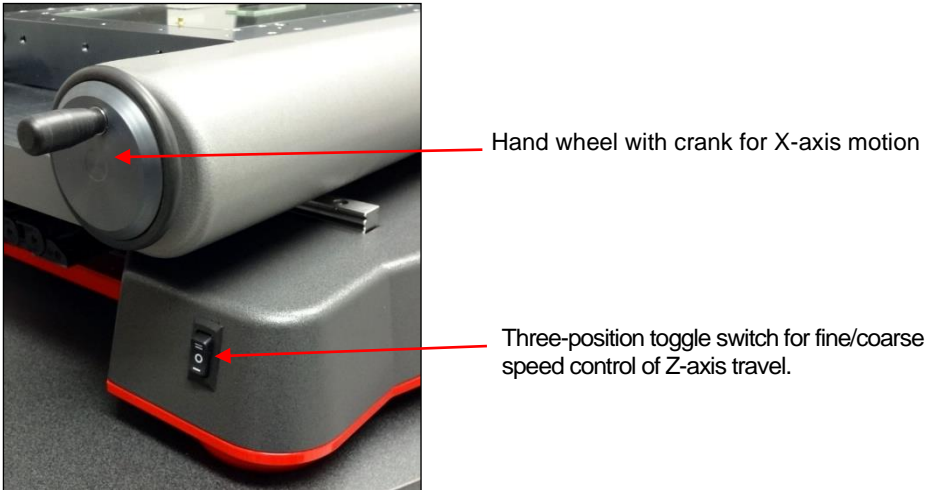


Figure 18. Left Side System Controls

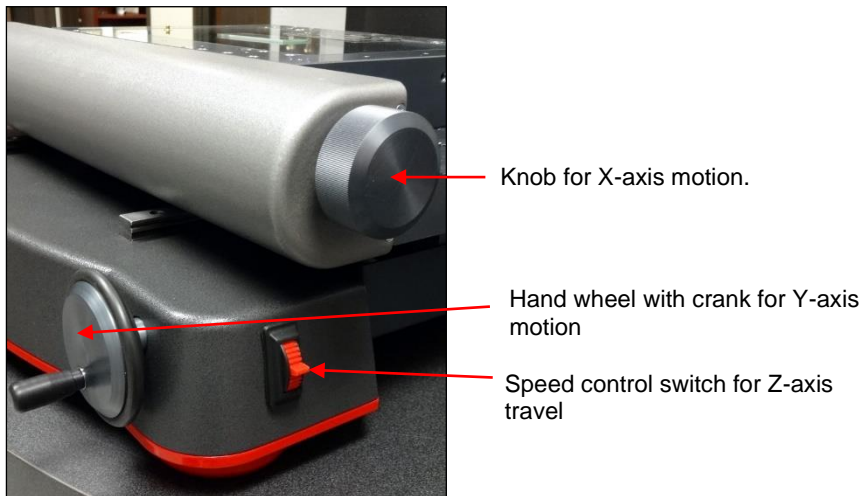


Figure 19. Right Side System Controls

6.3 Verifying Basic M3 Software Operations

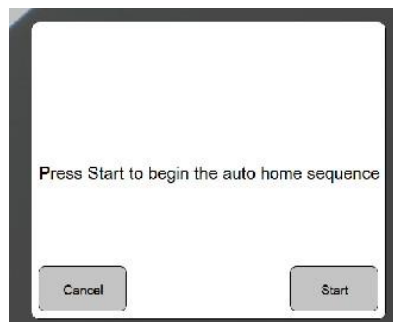
The following information provides basic instructions for operating the M3 software. For detailed information, refer to the ***MetLogix M3 Video and FOV Inspection Software User's Guide*** included with your system.

To start the M3 software, perform the following steps:

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



This action displays the interface below.



2. Select Start or touch the Start button on the screen. You will need to move the hand cranks until the screen tells you that that axis is homed.
3. Once the machine is homed, the screen indicates the machine is homed and there is a green checkmark in the upper right corner of the screen. Touch or click on the screen.



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

6.4 Changing Optics Assemblies

MVR systems are equipped with a bayonet optics mount that allows optic 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. Refer to the following figure.



Figure 20. 6.5:1 Zoom Optics assembly (left), Telecentric Optics Assembly (right)

Before You Begin

Before you begin removing the optics assembly, review the following information to prevent damage to the optics:

- Use two hands to remove a lens assembly, as it is heavy and is suddenly released. A drop onto the stage glass could break the lens and the stage, causing 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. 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.

Procedure

To remove a lens assembly from the system, perform the following steps and refer to the following figure:

1. Detach the electrical connections from the ring light by doing the following:
 - a. Pry the plastic latch open with a flat-blade screwdriver.
 - b. Separate the two connector halves.



Figure 21. Unplugging the Ring Light Connector

2. Using two hands, turn the optical assembly a quarter-turn counterclockwise. The assembly will “quick” release.
3. Reverse the process to reinstall the optics assembly.



Figure 22. Removing the Optics Assembly

6.5 Optimizing Substage Illumination

Background

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 zoom optics.

Procedure

Access to the substage lighting requires that the glass plate be removed from the MVR stage. To remove the glass plate, perform the following steps:

1. Remove the four screws that secure the glass plate to the stage.
2. Once the screws have been removed, place two fingers in the spaces vacated by the screws and pry up one side of the glass plate. Alternatively, use a suction cup to pull up one side of the glass plate.

6.6 Mechanically Leveling the Stage Glass

Background

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. 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.

Procedure

To mechanically level the stage glass, refer to the following figure and perform the following steps:

1. Using a 2.5 mm Allen wrench, adjust the screws as follows:
 - Turn a screw clockwise 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.
2. Orient the washers as shown in the following figure, keeping them barely compressed so that they have an adjustment range.
3. Four-point support will provide pivot action around two diagonal axes, make screw adjustments until the image remains in focus and the glass plate no longer tips around a diagonal axis.

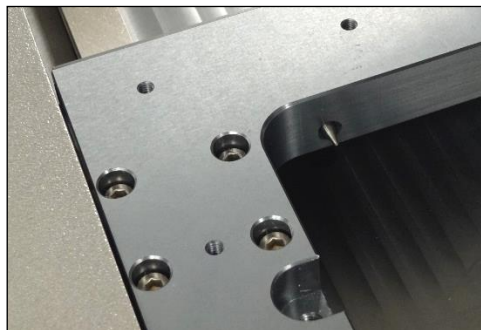


Figure 23. Stage Plate with Conical Tip

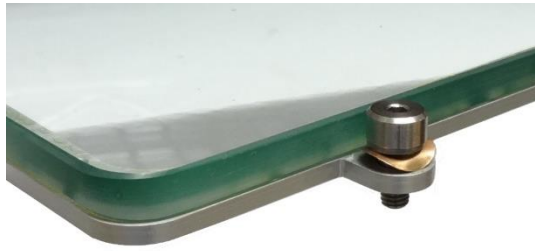


Figure 24. Glass Plate with Steel Base

6.7 Fixturing Parts

Parts must be fixtured securely to prevent part movement during measurement. In addition, 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. Refer to **MetLogix M3 Video and FOV Inspection Software User's Guide** for details.

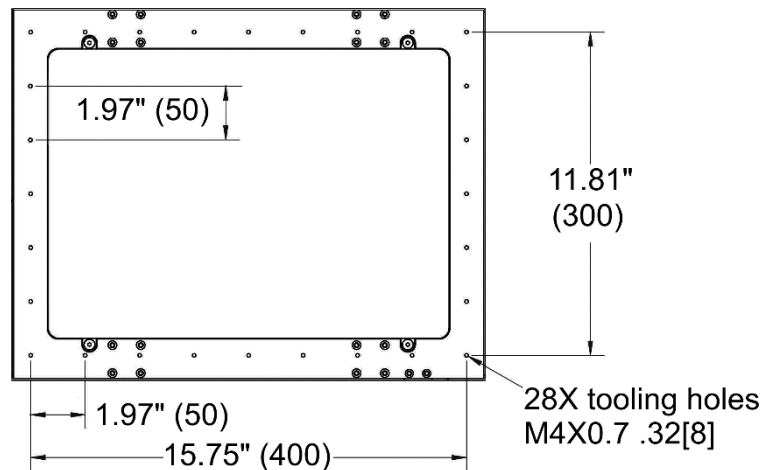


Figure 25. MVR300 Tooling Holes

7 Understanding Measurement Strategy

MVR systems can be operated with any of six 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 plane 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.

7.1 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 51x38 mm (2.00 x 1.50 inches). If the entire part cannot fit into the FOV, move the stage by up to 200 mm (7.9 inches) for the MVR200 or 300 mm (11.8 inches) for the MVR300, and the M3 software will seamlessly integrate FOV measurements with encoder readings from stage motion.

7.2 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 inches) 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.

7.3 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 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.

7.4 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 of a magnification can 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 might not need to be inspected at high magnification. Select the magnification best suited for the requirements.

7.5 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.

8 Maintaining the System

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.

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

8.1 Performing Daily Inspections

On a daily basis, inspect your system for general safety and basic functionality:

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

8.2 Performing Weekly or Monthly Maintenance

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

- Inspect the system for cleanliness. If dirty, refer to “Cleaning the System” later in this section.
- Verify that the stage control mechanisms move freely. If it binds, 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 any grease or other lubricant.
- Check the system for calibration against a certified chrome-on-glass standard.

8.3 Verifying Zoom Optics Alignment

The system's zoom optics (if ordered) should be verified regularly to ensure accurate measurement. Parfocality, parcentricity, and squareness verifications are straightforward and can be performed as often as desired. Focus is adjusted as needed by changing the distance between the lens and the surface being viewed.

Caution

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.

8.3.1 Verifying Zoom Optics Parfocality and Focus

Definition

Parfocality is the condition in which the video image will remain in 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. A magnification (mag) checker is an ideal part to check parfocality. Refer to "Spare Parts and Accessories" to order a magnification checker from Starrett.

Procedure

To check parfocality, do the following:

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.

8.3.2 Verifying Zoom Optics Parcentricity

Definition

Parcentricity describes the condition wherein a feature will remain 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.

Procedure

To check parcentricity, do the following:

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. Refer to the **MetLogix M3 User Guide** 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.

8.3.3 Verifying Zoom Optics Squareness**Definition**

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.

Procedure

To check squareness, do the following:

1. Place the mag checker or other suitable inspection part on the stage and secure properly.
2. Select the crosshair image tool in the M3 software and verify that it is at its defined center position. Refer to the **MetLogix M3 User Guide** for details.
3. At low magnification, 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.

8.4 Verifying Calibration

Calibration should be verified periodically depending on user requirements and system usage and should be performed 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.

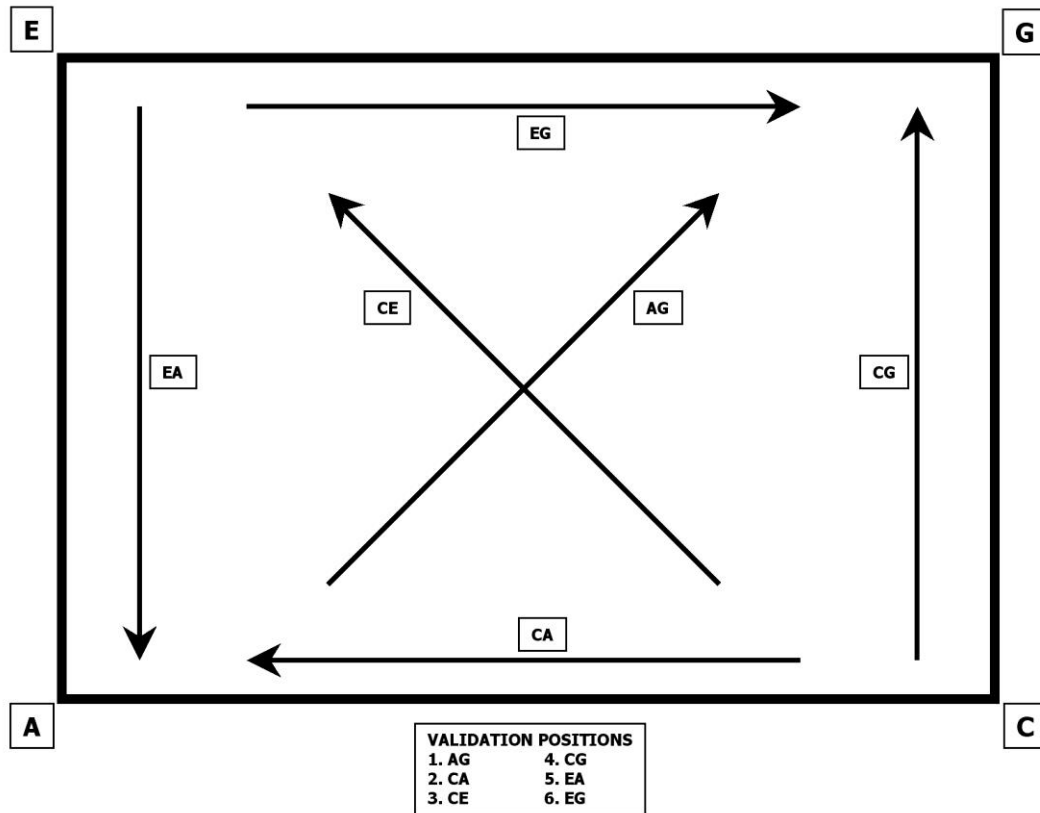


Figure 26. Calibration Verification Standard Placement

Procedure

To validate calibration, perform the following steps:

1. Place the calibrated verification standard in one the six positions on the glass stage as illustrated in the previous figure. Secure the standard with hot melt glue or other suitable retaining method so that stage translation cannot move the standard under any condition.
2. Skew the center of the two end circles. Refer to the *MetLogix M3 User Guide* 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 ten times.
4. Calculate the absolute average deviation for each of the five 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.

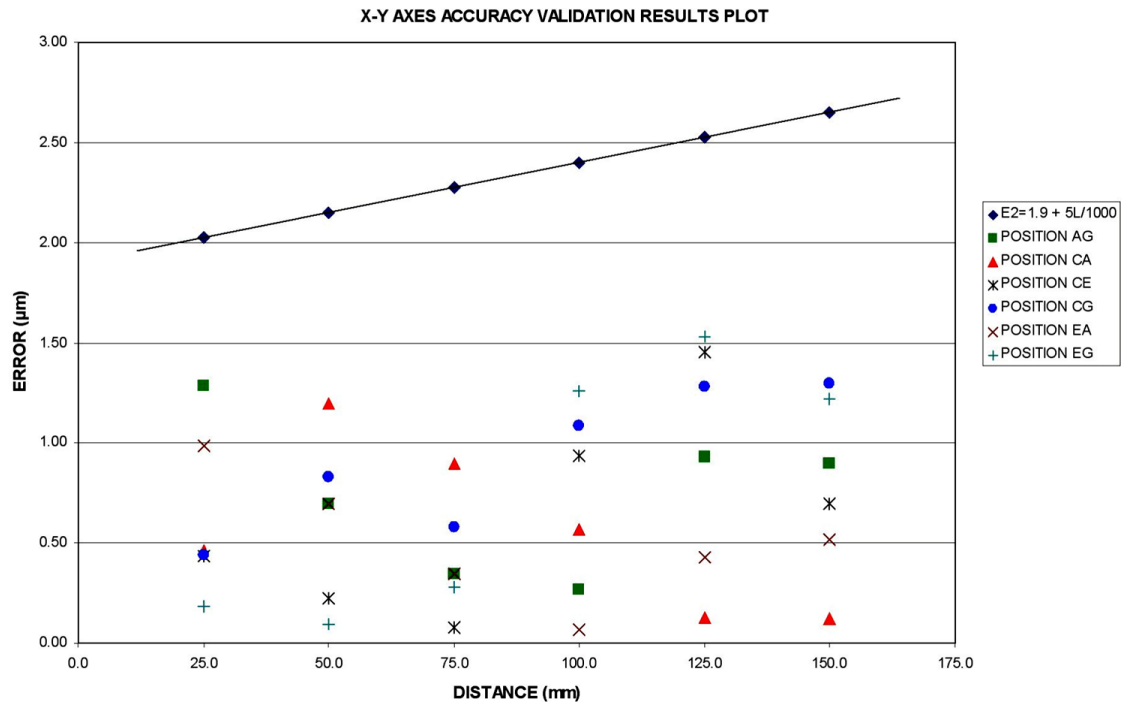


Figure 27. Calibration Error Chart Example

8.5 Cleaning the System

The MVR 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.

8.5.1 Cleaning External Surfaces

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

Most critical components are covered and require no user service. If the stage mechanics require service, contact your Starrett representative.

8.5.2 Cleaning Optics

<p style="text-align: center;">Caution</p> <p>Do not touch lens surfaces with your fingertips. Fingerprints can destroy optical coatings over time. Only clean optical surfaces with proper cleaning supplies, and then only when necessary.</p>

To clean the lens, refer to the following guidelines:

- If a lens is covered with loose dust, do the following:
 - Use a can of optical grade (oil-free) canned compressed air to blow off the dust. Be careful not to shake the lens, or propellant can blow onto the lens.
 - Use a lens brush to gently wipe off the dust.
- If the lens is soiled with greasy deposits which cannot be blown or brushed off, use an alcohol-based commercial lens cleaner and a lens tissue or a lens cloth. These items are available from camera stores.
 - Apply the lens cleaner generously to dissolve the grease, and then blot off the lens cleaner and dissolved grease using minimum motion.
 - Avoid rubbing the lens, since hard particles from the deposit or the lens cloth could scratch the optical coatings.
- If the greasy deposits do not come off with the lens cleaner, use a stronger solvent such as reagent-grade acetone as a last resort.
 - Gently wipe the lens surface while moving the lens cloth to always present a clean surface to the lens.
 - Wipe in a circular manner moving from the center of the lens toward the outer edge.
 - Do not reuse the lens cloth to avoid redepositing contaminants.

8.5.3 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.

8.6 Spare Parts and Accessories

The following tables provide the spare parts and the available accessories for the MVR systems.

Spare Parts

Description	Part Number
MVR200 stage glass	4865-1
MVR300 stage glass	5359-1

Accessories

Description	Part Number
Combination field of view and magnification checker calibration standard	9123
150mm line standard	1434-1
200mm line standard	8736-1

9 Glossary

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

A

accuracy

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

alignment

The state or orientation of an object or feature with respect to a set of datums or the act of putting an object or feature into a desired state or orientation.

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

B

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.

C

CAD file

See Computer-Aided Design.

calibration

The formal comparison of measuring equipment against a standard of higher level (a national standard defined in the U.S. by NIST) under controlled and specified conditions to document the accuracy of the instrument being compared.

CCD

See Charge Couple Device.

charge couple device (CCD)

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

CE (Conformité Européenne) marking

A certification mark that indicates conformity with health, safety, and environmental protection standards for products sold within the European Economic Area (EEA).

CNC

See computer numerical control.

computer-aided design file (CAD)

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

computer numerical control (CNC)

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

D**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

See Drawing Exchange Format.

Drawing Exchange Format (DXF)

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

E**electromagnetic compatibility (EMC)**

The ability of electrical equipment and systems to function acceptably in their electromagnetic environment, by limiting the unintentional generation, propagation and reception of electromagnetic energy which may cause unwanted effects such as electromagnetic interference (EMI) or even physical damage in operational equipment.

EMC

See electromagnetic compatibility.

F**fiducial point**

A point (or line) on a scale used for reference or comparison purposes.

field of view (FOV)

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

field of view measurement (FOV measurement)

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

focus

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

FOV

See field of view.

I**Illumination, back**

Lighting applied from the back of the object to create a silhouette when the object is viewed by the 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.

L**LED**

See light-emitting diode.

light-emitting diode

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

M**mag**

See magnification.

magnification

The process of enlarging the apparent size, not physical size, of something.

magnification, lens

In a vision metrology system, the image size in the CCD plane divided by the corresponding object size.

magnification, image

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

measurement uncertainty

An estimate of the uncertainty of a measurement. Usually comprised of instrumental uncertainty and a number of other factors such as procedural uncertainty, and environmental uncertainty.

megapixel (MP)

A unit of graphic resolution equivalent to one million pixels commonly used to describe the resolution of digital cameras.

MetLogix M3 software

The M3 video inspection software is advanced metrology software for performing two and three axis measurements in encoder-based systems and field of view systems at high levels of precision and accuracy. M3 software is included with MVR series systems.

metrological traceability

Property of a measurement result whereby the result can be related to a reference through a documented unbroken chain of calibrations, each contributing to the measurement uncertainty.

micrometer (μm)

One millionth of a meter.

MP

See megapixel.

N**National Institute of Standards and Technology (NIST)**

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

NIST

See National Institute of Standards and Technology.

P**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 the individual light emitters of an LCD video monitor.

R

repeatability

The closeness of agreement among a number of consecutive output values measuring the same input value under the same operating conditions, approaching from the same direction.

resolution

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

S

skew

Misalignment of the part with respect to the X and Y axes. Skewing creates 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.

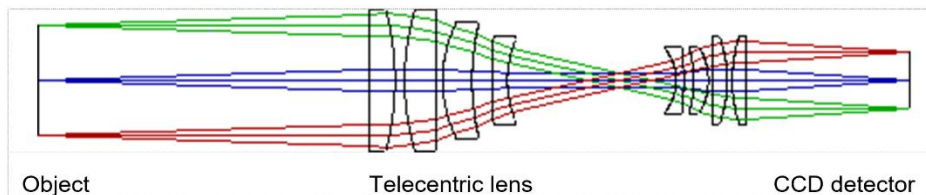
Small form factor (system) PC

A space saving personal computer where all electronics, disk drives and I/O connections are in the same enclosure.

T

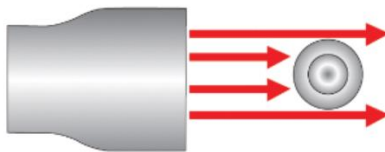
telecentric

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



telecentric illumination

Optics are used to direct light from a fiber optic light guide or LED onto an object under inspection, producing a high contrast silhouette. A telecentric illumination increases edge contrast and measurement accuracy by decreasing diffuse reflections from the object. See the following figure.

**tetrafluoroethylene (TFE)**

A self-lubricating polymer coating used on precision lead screws.

TFE

See Tetrafluoroethylene.

V**VED**

See video edge detection.

video edge detection (VED)

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

Z**zoom optics**

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