AV300, AV350, AV450 CNC Vision Metrology Systems with MetLogix M3 Software

User Manual

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CE

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1. PREFACE

1.1 Welcome

Thank you for purchasing an AV300, AV350 or AV450 Automatic Vision (CNC) 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

AV300, AV350, 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 Product Safety, EMC Testing and Evaluations were provided by Garwood Laboratories, San Clemente, CA 92672, USA. 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 Automatic Vision (AV) metrology systems with M3 software combine precision mechanics, video edge detection (VED), powerful vision metrology software, and motorized operation under computer control. Operation can be under full computer numerical control (CNC) for large runs, or manual for individual measurements or short runs with inputs from a pendant with a joystick and trackball. These systems have proven themselves in quality assurance, inspection labs, manufacturing assembly, and research facilities worldwide.

AV300 systems feature a 513 x 275 mm (20.2" x 10.8") stage, 300 x 150 x 135 mm (12" x 6" x 5.5") of CNC XYZ travel. These systems are available as a benchtop system or with an ergonomic workstation that supports the system's metrology unit, 24" touch screen monitor and PC, wireless keyboard, and wireless mouse.

AV350 and AV450 systems come standard with a machine pedestal, which supports the metrology unit on a solid granite base, and a separate computer cart, which supports the system's touch screen monitor, wireless keyboard, and wireless mouse, and 12:1 motorized zoom optics. Both systems feature the same 716 x 549 mm (28.2" x 21.6") stage. AV350 systems provide 350 x 350 x 200 mm (14" x 14" x 8") of CNC XYZ travel, while AV450 provide 450 x 350 x 200 mm (18" x 14" x 8") of CNC XYZ travel.

Video Imaging, as ordered, can be provided by a 1.3 Mpixel color CCD camera with factory installed 6.5:1 or 12:1 zoom optics, or by a 2 Mpixel color video camera with a bayonet lens mount which accepts a 6.5:1 motorized zoom optics or any of six available fixed-magnification telecentric lenses (0.30X, 0.50X, 0.80X, 1.0X, 2.0X, 4.0X).

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 adjustable on a motorized CNC Z-track for shadow control.

A touch-probe is optional and is integrated with the 3D version of MetLogix M3 CNC software. The touch probe allows the measurement of tilted, tapered and vertical surfaces which could not be measured with video edged detection alone.

System control is provided by a MetLogix M3 CNC Controller and a computer which runs MetLogix M3-VED-CNC software under Windows 7 Professional. Programmable features include X-Y-Z motion, optical zoom, 2- or 3-channel illumination, 2D (X-Y) geometrical constructs for VED systems, and 3D geometrical constructs for VED systems with the optional touch-probe. M3 software is described in a separate manual by MetLogix. The AV300, AV350 and AV450 systems utilize a separate 24" touch-screen monitor and PC as the primary operator interface.

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

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.

control

Feature	AV300-M3	AV350-M3	AV450-M3
Physical Configuration	Benchtop system with optional workstation for metrology unit and PC.	Floor standing with machine pedestal and computer cart for monitor and PC.	
X-Y-Z Stage Travel	300 x 150 x 135 mm (12” x 6” x 5.5”)	350 x 350 x 200 mm (14” x 14” x 8”)	450 x 350 x 200 mm (18” x 14” x 8”)
Window Aperture	340 x 198 mm (13.4” x 7.8”)	389 x 389 mm (15.3” x 15.3”)	420 x 540 mm (16.5” x 21.3”)
Stage Dimensions	513 x 275 mm (20.2” x 10.8”)	716 x 549 mm (28.2” x 21.6”)	
Stage Load Capacity	11 kg (25 lbs)	11 kg (25 lbs)	
Base	Cast aluminum	Granite	
X-Y Accuracy (E2)	1.9 µm + 5L/1000	2.5 µm + 5L/1000	
Z accuracy (E1)	2.5 µm + 5L/1000	2.5 µm + 5L/1000	
Scale Resolution	0.1 µm		
Control System Software	MetLogix 2D or 3D CNC software (as ordered).		
Lighting Sources (as ordered)	**1.** Fiber-optic light delivery from 150-Watt quartz halogen lamps to a fixed ring light, sub-stage light, and optional through-the-lens coaxial light. **2.** LED ring light can be fixed, or Contrast Master quad ring light, LED back light, and optional through-the-lens coaxial light. LED brightfield quad light with individually adjustable side illumination.		
Camera Types	1.3 or 2 MPixel color CCD (as ordered), USB 2.0 digital interface		
Camera Optics	6.5:1 zoom lens, motorized	12:1 zoom lens, motorized	
Computer	24” touch-screen monitor and PC	Rack-mount PC with 24” touch-screen monitor	
Screen Resolution	1920 x 1080 pixels		
Computer Controls	Touch-screen, wireless keyboard, wireless mouse		
Manual Positioning	Pendant with joystick and trackball.		
Zoom Control	Motorized under M3 software control.		
Lighting Control	Programmable under M3 software control.		
Calibration	To NIST traceable calibration standards.		
Optional Items	Quad ring light, auxiliary lenses (0.5X, 1.5X, 2X), parts fixturing, NIST traceable calibration standards, workstation for AV300 system.		
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. Motorized on Z-track with CNC control by M3 software. Height adjustable from bottom of video probe to 100 mm (4”) below.		

Touch Probe Option Kit Probe Head Probe Body 1 Probe Body 2 Stylus Probe Tip Repeatability	 Renishaw PH6 Renishaw TP20 SF (standard force) Renishaw TP20 MF (medium force) Renishaw 20 mm long stylus with 2 mm ruby tip. 0.35 µm
Error Due to Z Travel	< 7.5 µm per 150 mm (< 0.0003" per 150 mm) before software compensation
Warranty	One year

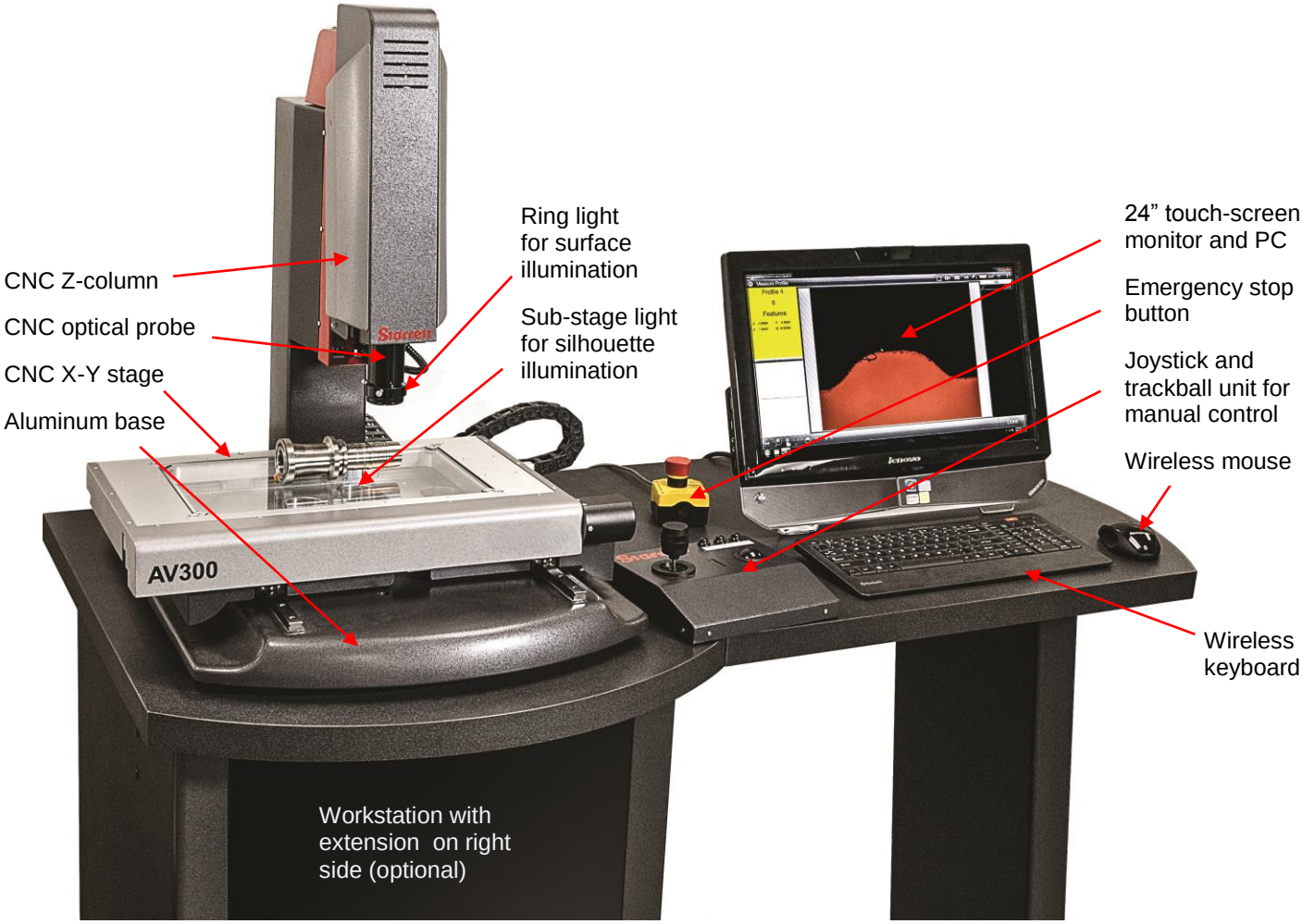
Zoom Optics	**6.5:1 Zoom**	**12:1 Zoom**
Magnification on CCD*	0.47X to 3.0X	0.40X to 4.7X
Field of View	10 to 1.6 mm (0.39" to 0.06")	10 to 1.6 mm (0.39" to 0.06")
Magnification on Monitor	31X to 198X	26X to 310X
Zoom Working Distance	88 mm	
Available Auxiliary Lenses	0.5X, 1.5X, 2.0X	

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

***** Stated magnifications is the mage size on the camera CCD divided by the corresponding object size at 1:1 M3 Software pixel setting.

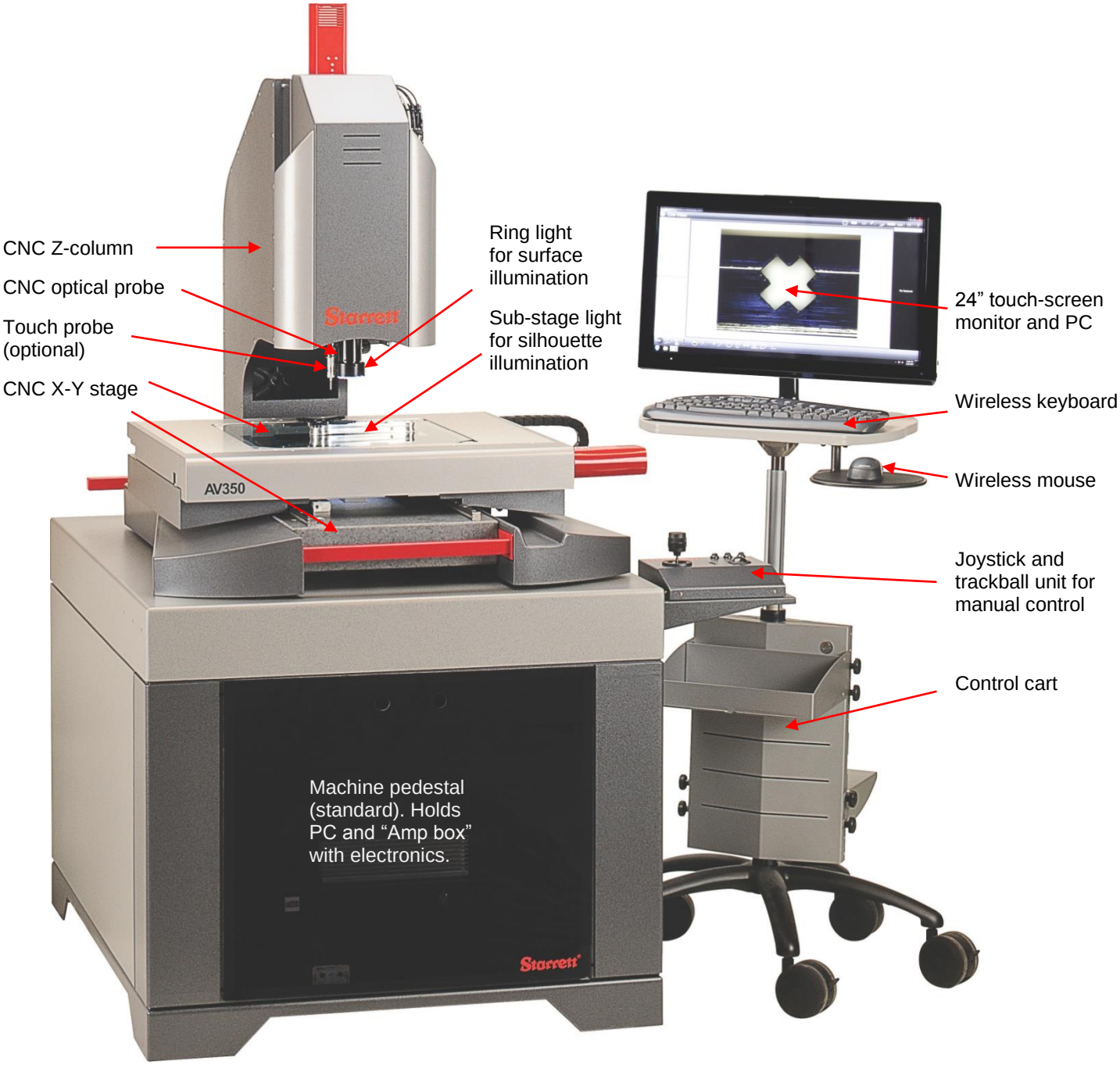
Disclaimer: Due to continual product improvements, specifications may change without notice.

2.1 AV300, AV350, AV450 System Components



AV300 CNC System Components on Optional Workstation

MetLogix M3 CNC Control Unit (installed in workstation)



AV350, AV450 CNC System Components

2.2 Component Description

1) **System Computer.** Runs MetLogix M3-CNC software under Windows 7 professional. The computer is an 24" touch screen monitor and PC for AV300 M3 systems, or a rack-mount PC with a separate 24" touch-screen monitor for AV350 and AV450 M3 systems. In either case, 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. The monitor displays parts views, geometrical constructs, and readings. Operator inputs can be via the PC's touch-screen or a wireless keyboard and mouse. M3 software operation is provided in a separate M3 manual by MetLogix.

2) **MetLogix M3 CNC Control Unit.** Interfaces all-in one PC to metrology unit. Reads liner encoders, reads output of joystick and trackball unit, drives motors for CNC operation, and controls lighting. Located on benchtop or inside workstation (AV300), or inside machine pedestal (AV350 and AV450).

3) **Metrology System Base.** Cast aluminum for AV300, granite for AV350 and AV450.

4) **X-Y Stage.** Motorized with DC servo or stepper motors under control of M3 CNC software. Made from precision machined aluminum. Surface mounting holes allow customer-designed fixtures for part support. Travel is 300 x 150 mm (12" x 6") for AV300, 350 x 350 mm (14" x 14") for AV350, and 450 x 350 mm (18" x 14") for AV450.

5) **Z-Column.** Motorized with DC servo or stepper motors under control of M3 CNC software. 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. Height adjustment is 135 mm (5.5") for AV300, and 200 mm (8") for AV350 and AV450.

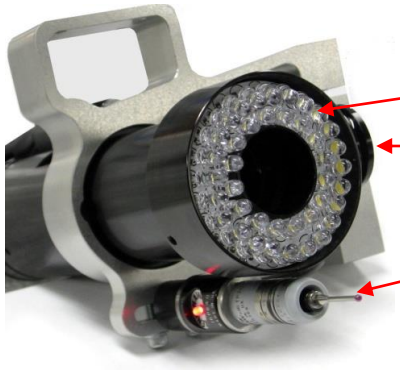
6) **Optical Probe Assembly.** Captures the part image for display and for video edge detection (VED). The imaging system, as ordered, can be a 1.3 Mpixel color CCD camera with factory installed 6.5:1 or 12:1 zoom optics, or a 2 Mpixel color video camera with a bayonet lens mount which accepts 6.5:1 motorized zoom optics or any of six available fixed-magnification telecentric lenses (0.30X, 0.50X, 0.80X, 1.0X, 2.0X, 4.0X). The bayonet mount allows quick change of optics.

   The settings of the video camera are preset at the factory and should not be modified. For all optics, focus is determined by the height of the optical probe over the surface to be analyzed. This height is controlled by M3 software. For the zoom optics, an optional 0.5X auxiliary lens can double the field of view while cutting magnification in half, and optional 1.5X and 2.0X auxiliary lenses can increase magnification by 1.5X or 2.0X while reducing the field of view.

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 and can further be adjusted in height by 100 mm (4") under CNC control by M3 software. 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.

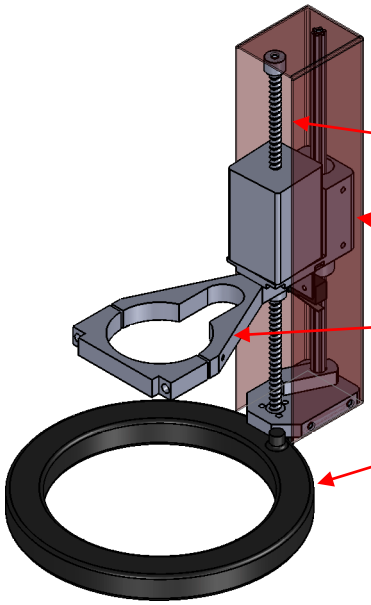
9) **Silhouette Illumination.** Provided by a sub-stage light. The light source can be LEDs in the sub-stage light or a 150W quartz-halogen lamp with fiber-optic delivery, as ordered. Intensity control of both lighting alternatives is via M3 software.



Standard LED ring light

Entry port for optional coaxial illumination

Optional touch probe



Lead screw for 10 cm (4”) of height adjustment

CNC controlled drive motor

Clamp for attachment to optical probe

Optional add-on LED quad dark-field ring light with intensity adjustable in four quadrants.

10) **Touch Probe Option.** An optional touch probe can be installed in the base of the optical video probe as illustrated above. This allows the system to make 3D measurements and create 3D constructs from parts with vertical and slanted surfaces. Touch probe operation is supported by M3 CNC 3D software.

11) **Joystick / Trackball Operator Control Unit.** Used for manual motion control, probe height control, zoom control, and light intensity control. The output of the control unit is processed by M3 software which then issues the required control commands. The unit is used for manual inspection and short runs, also for teaching inspection routines for automated inspection. The back of the unit includes a duplicate red Emergency Stop (E-Stop) button.

12) **Ergonomic Workstation.** Available as an option with AV300 systems. Supports the AV300 metrology unit. Houses M3 controller, M3 control unit, power supplies, and quartz-halogen lamp housings (non-LED systems). A workstation extension can be attached to right or left side of main unit.

13) **Machine Pedestal.** Standard with AV350 and AV450 systems. Supports metrology unit. 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”). A small shelf, which is attached to the side of pedestal and supports the joystick and trackball unit, adds 25 cm (10”) to width.

14) **Control Cart.** Standard with AV350 and AV450 systems. Supports 24” touch screen monitor and PC, keyboard and mouse. Height of cart is adjustable by 25 cm (10”) so that the system can be operated from a standing or sitting position.

2.1 Manual Controls via Pendant

Push button to toggle between slow and fast control. Applies to X-Y and Z axes.

Deflect joystick from left to right for X-axis control, from front to back for Y-axis control.

Rotate joystick for Z-axis height control.

Push button to toggle between trackball control of X-Y axes or Z axis.

Push button to toggle between axis lock, where only one axis can be moved at one time, and non-axis lock.

Rotate trackball for X-Y or Z fine control as selected by left pushbutton.

2.2 Emergency Stop (E-Stop) Switches

M3 CNC systems come with two latching E-Stop switches as a safety feature. These are wired in series so that either one can remove power from the motors.

Press red button to cut power. Rotate button clockwise to release.

Press red button on back of pendant to cut power. Press again to reapply power.

Button in = energized
Button out = de-energized

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.

2.4 Changing Bayonet Mounted Optics

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

NOTE	The positioning of different optics assemblies in the bayonet mount is not exact. 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. Different LED ring lights fit all telecentric lens assemblies from 0.3X to 4.0X. This ring light can be transferred from one telecentric lens to another when these have been removed from the system.

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

To remove a lens assembly from the system, first detach the electrical connections of the ring light. Note that the electrical connectors are latched. Pull and twist the two halves of the plastic connector halves to separate them. Give the optical assembly a quarter turn counterclockwise, and the assembly will suddenly be released. Reverse the process to reinstall.

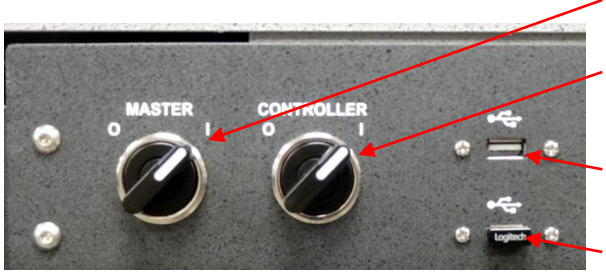
Cautions 	• Use two hands to remove a lens assembly, as it is heavy and is suddenly released after giving it a quarter turn counterclockwise. A drop onto the stage glass could break the lens and the stage glass, causing extensive damage. • Do not leave the camera unprotected by a lens assembly to minimize dust settling on the CCD sensor surface. • Do not touch optical surfaces, since oil from your hands can permanently damage optical coatings. • Place unused lens assemblies in a polyethylene Ziploc bag for dirt protection. • Store unused lens assemblies in a safe place, since they are breakable and expensive.

2.5 Safety Considerations

General Safety 	**NOTE:** AV Series 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 these systems. Follow all standard safety protocols for electrical and mechanical equipment in addition to all guidelines outlined in this manual. Failure to exercise proper safety practices may result in damage to the equipment, serious personal injury or death.
Electrical Safety 	**WARNING:** Follow the guidelines below to protect the equipment, to prevent voiding the warranty, and to avoid hazardous electrical conditions: • Power receptacles used with this equipment must be properly grounded 3-prong polarized 120 Vac types for use in North America, or appropriate safety-rated receptacles as used outside of North America. • Keep component air vents clear, clean and free from dust and debris to provide proper circulation to electrical components and to avoid overheating. • Keep all liquids away from the system. • Ensure that the ground is clean, dry and free from debris at all times. • Do not operate the equipment in excessively humid conditions (> 90% relative humidity). • Do not operate the equipment in an explosive environment, such as around volatile or flammable solvents. • Do not open the metrology cabinet or component housings, except to change light bulbs. All other components are to be serviced by factory-authorized personnel only. • Do not leave covers off the machine components when operating.
	Disconnect power, or do not plug in the power cord, if hazardous conditions exist such as: • Damaged or frayed power cord. • Damaged or improperly grounded power receptacle. • Equipment exposed to excessive moisture or liquid spills. • Impact or damage to the equipment. Have the system inspected by authorized personnel before operating. • Ongoing equipment serviced by a technician
Mechanical Safety 	An AV (CNC) metrology stage has motorized mechanical components which move under computer control. • Do not place hands or loose articles of clothing near the moving parts. Failure to observe this warning may result in personal injury and equipment damage. • Familiarize yourself with operation of the system's two E-Stop switches, as shown on page 12 of this manual. Press the closest E-Stop switch immediately if continuing motion would cause a collision or injury. • Do not reapply power to the motors until the cause of the mechanical problem has been understood and removed.

2.6 System On/Off Controls

In AV350 and AV450 systems, the front panel of the pedestal has a 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.



Master On/Off switch for system, including the PC. "|" is "On", "O" is "Off.

On/Off switch for M3 controller only. Used to reset and initialize the M3 controller.

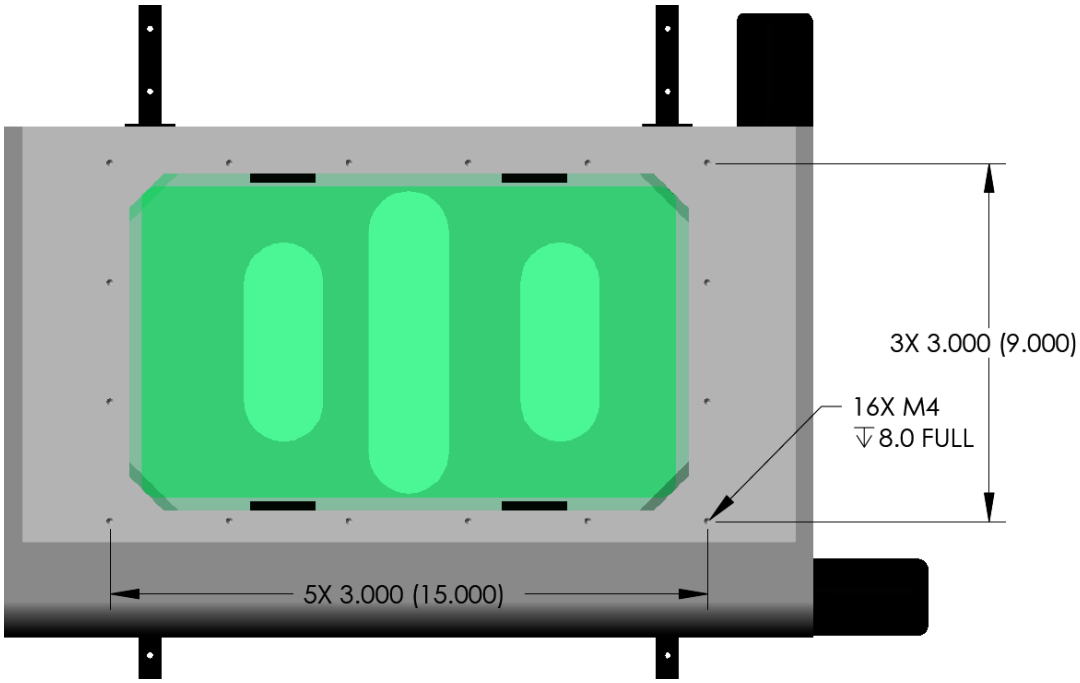
Spare USB port to PC. Normally used to transfer data to a thumb drive.

Wireless Logitech transmitter. Connects PC to wireless keyboard and mouse.

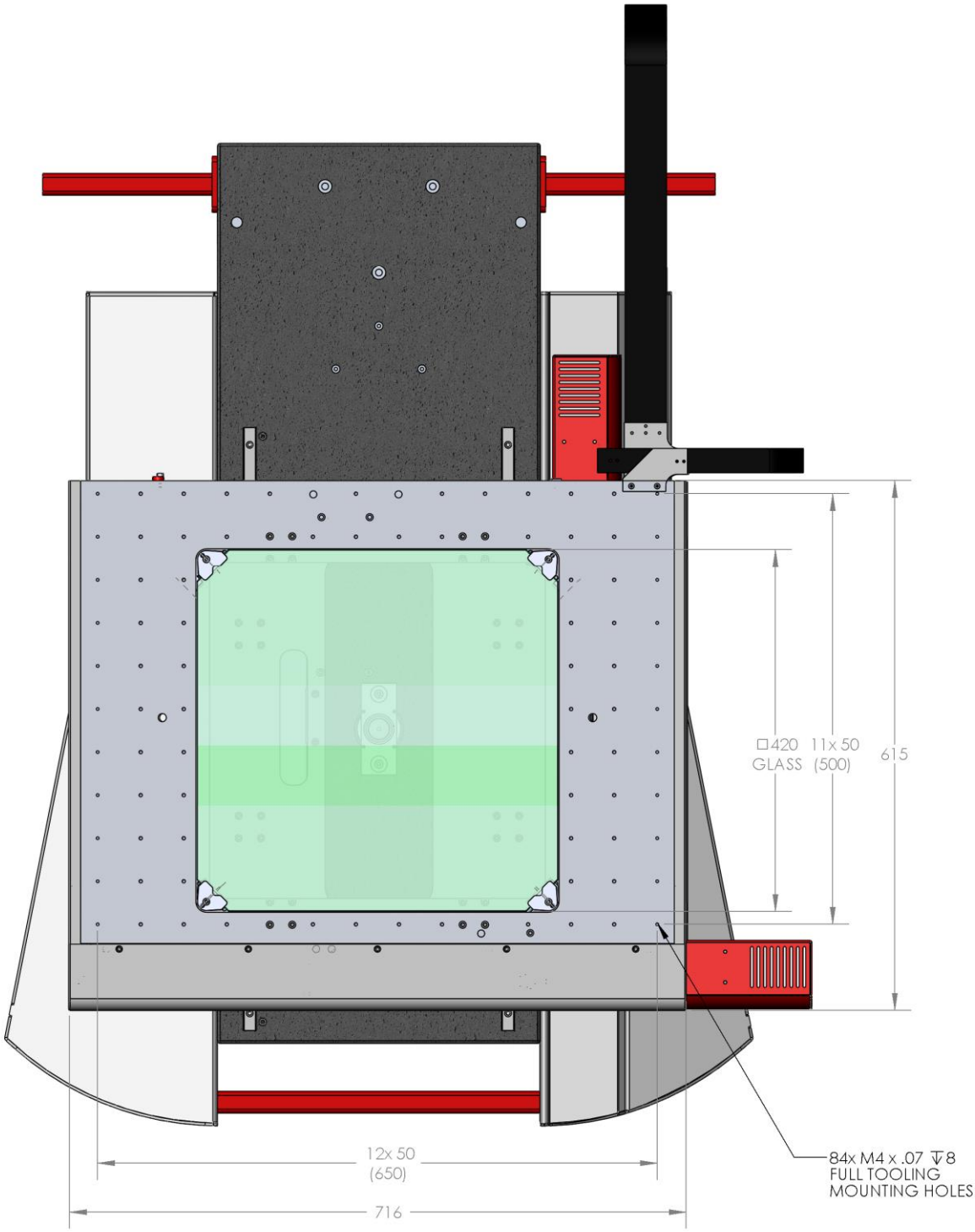
⚠	Before removing power, first close all computer files and applications, and then shut down the computer using the Windows "Shut down" button. Otherwise open computer files could be corrupted by the sudden loss of power.

2.7 Stage Plate Diagrams

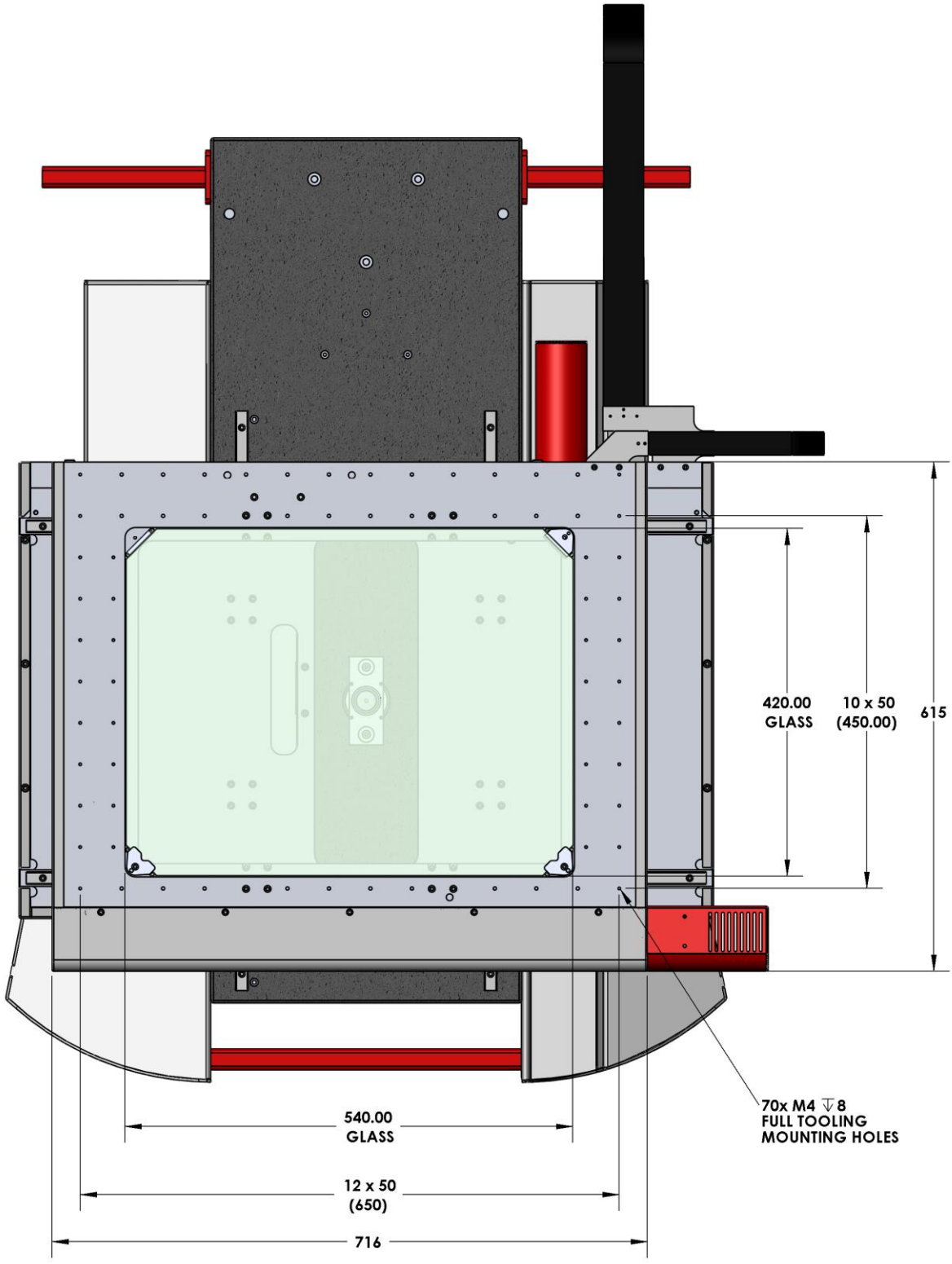
The Stage Plate allows attachment of customer-designed fixtures for part support. Please refer to the following diagrams for bolt-hole placement and size.



AV300 Stage Plate Diagram



AV350 Stage Plate Diagram



AV450 Stage Plate Diagram

3. INSTALLATION

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

3.1 Moving the Equipment

Starrett AV Series vision metrology systems are shipped in a large 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.

3.2 Uncrating the Equipment

The following items are typically required to uncrate and install Starrett 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. Needle nose pliers (6” long)
7. 6” crescent wrench (2 recommended)
8. Black cable ties

3.3 Placing the Equipment

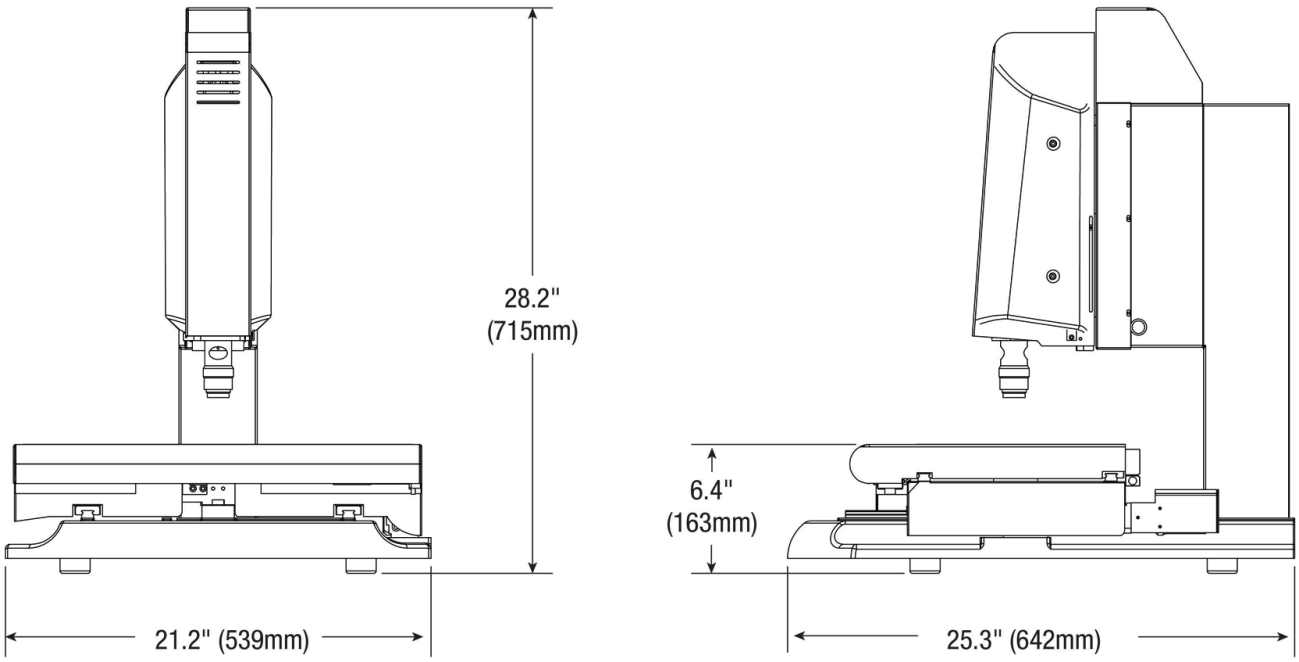
A clean operating environment is recommended to minimize the accumulation of dirt on the optics and on precision mechanical parts, such as lead screws and encoder scales.

AV300 systems are available in the form of components for installation on a customer-furnished benchtop, or as a complete system with an ergonomic workstation.

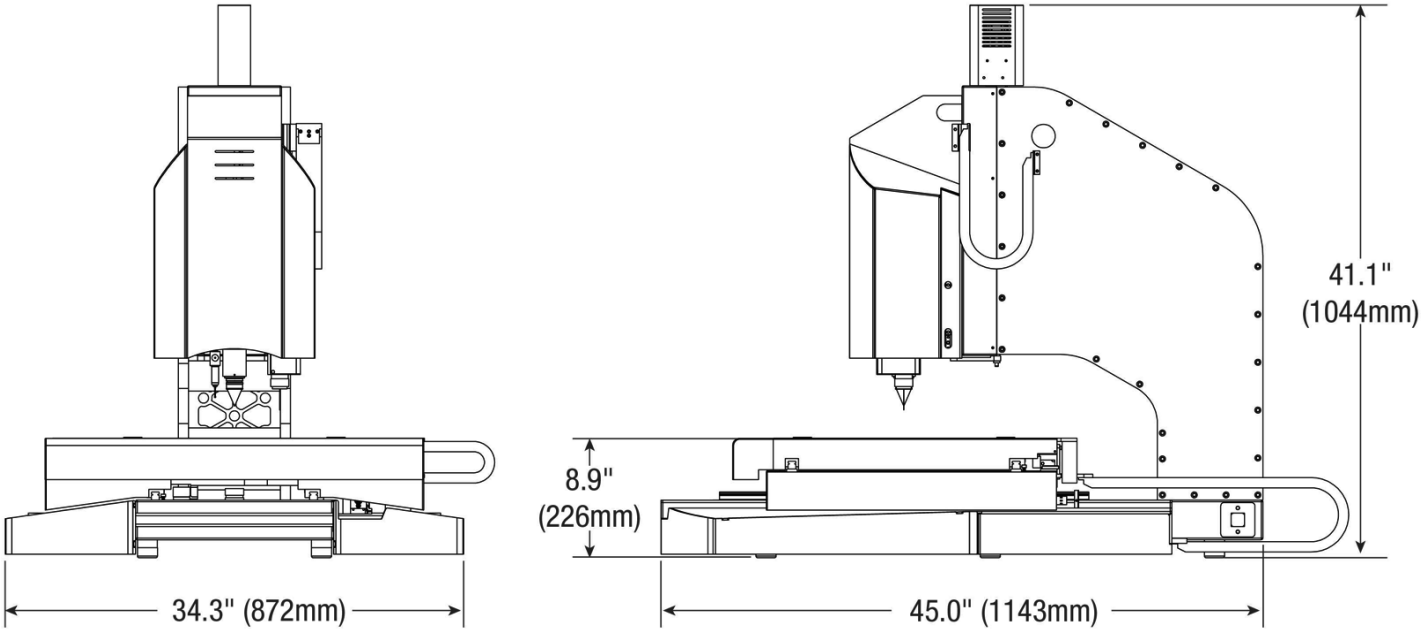
Component-level AV300 systems are designed to be installed at a height of approximately 85 cm (33.5”), which is the height of Starrett’s ergonomic workstation. A level work surface, as checked with a bubble level, is recommended, but is not essential. Allow 65 cm (25”) to right or left side of the metrology unit to position the 24” touch screen monitor and PC. An additional clearance of 30 cm (12”) or more is recommended on both sides for general access and to store parts and paperwork. Please refer to the drawings below for dimensions of the AV300 metrology unit.

Starrett’s ergonomic workstation with a side wings for AV300 systems measures 85 cm (33.5”) high, 154 cm (60.5”) wide, and 84 cm (33”) deep. The side wing, which supports the all-in-one PC, can be attached to the right or left side of the pedestal, which supports the metrology unit. The pedestal contains two shelves which can hold the M3 controller, LED controller, brick power supplies for the controllers, other electronics, parts, and paperwork. Please see the photo on page 9.

AV350 and AV450 systems come standard with a machine pedestal and a control cart which supports the video monitor, wireless keyboard, and wireless mouse. Please see the photo on page 10.



AV300 metrology unit outline dimensions



AV350 and AV450 metrology unit outline dimensions

3.4 Electrical Power

Brick-type power adapters

AV300 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. The AC adapters all accept 100/240 Vac power for worldwide use. They are normally plugged in a switchable outlet strip, which is shipped with the system and serves as the master power distribution point. The AC 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, dry location.

In AV350 and AV450 systems, the same “brick” type AC adapters are used for the M3 controller and illumination controller. These are installed in an “Amp box” in the pedestal. The rack-mount PC, which is also installed in the pedestal, is powered directly by the AC line. The PC, as well as the AC adapters, accept 100/240 Vac power for worldwide use. 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.

4. INSTALLATION

Your metrology system was 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.

4.1 Required Tools

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

4.2 Uncrating

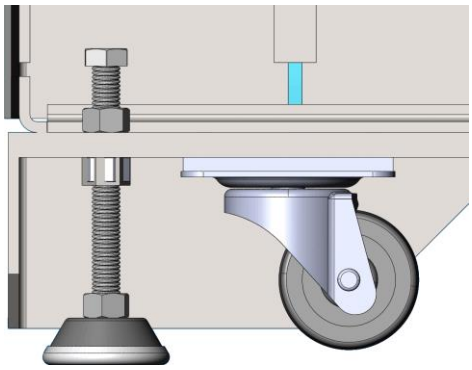
Remove the screws on the top of the crate and carefully remove the top. Remove one of the side panels for access to the contents. Remove and unpack all components. Verify that the contents match the packing checklist included in the documentation packet. Once the presence of all items has been verified,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

4.3 Placement of AV350 / AV450 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, and the 25 cm (10”) to the right or left side for the shelf that will hold the joystick / trackball unit.

4.4 Leveling of AV350 / AV450 Pedestal

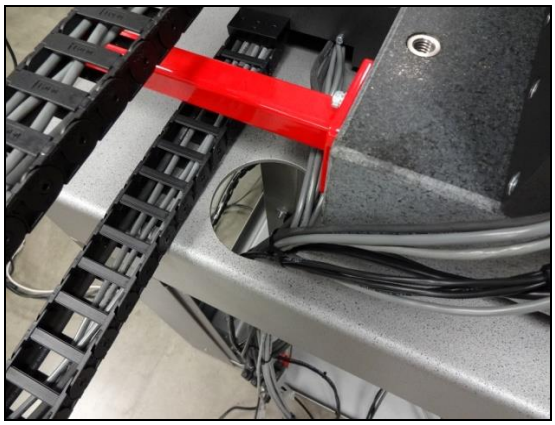
The pedestal includes a swiveling wheel on all four corners, plus an adjustable bolt which locks the pedestal in place and provides limited height adjustment. To lock the pedestal in place and adjust height, first turn the lock-nut on the bolt counterclockwise to its upper position. Then use a wrench 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

4.5 Lifting of AV350 / AV450 Metrology Unit

Red carrying hand in front of AV350



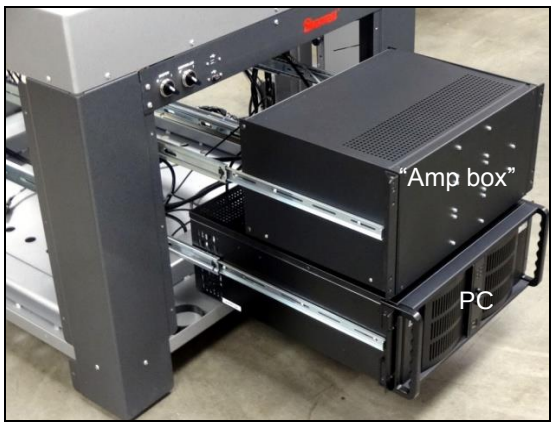
Red carrying handle on side of AV350

- **AV350 and AV450 metrology units include a granite base and are very heavy!** They come with permanently mounted red carrying handles to facilitate lifting and positioning. Proper materials handling and lifting procedures of equipment is highly advised and should be incorporated at all times. To avoid possible injury, professional machinery movers and equipment. Please contact supplier for further information.

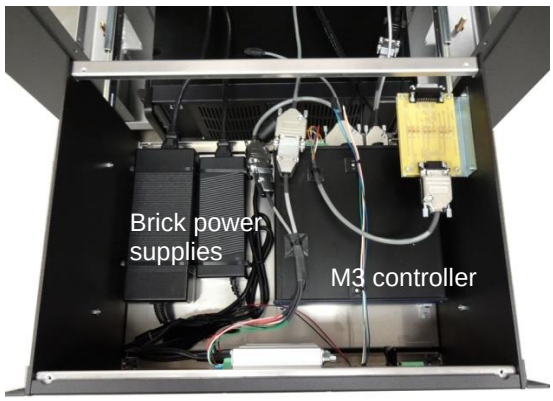
Removing Shipping Retainers

AV 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 them.

4.6 Wiring of AV350 / AV450 Pedestal



Pulled out PC and "Amp box"

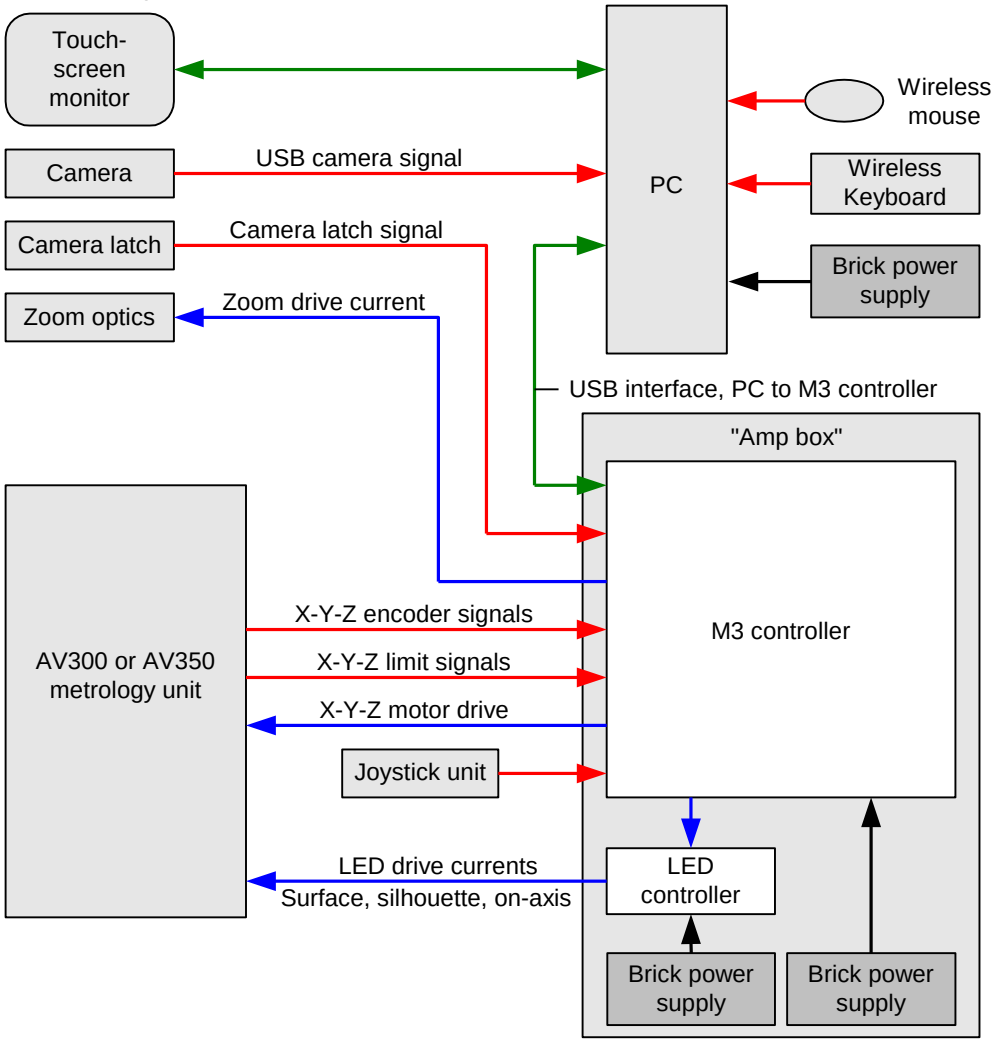


"Amp box" with top cover removed

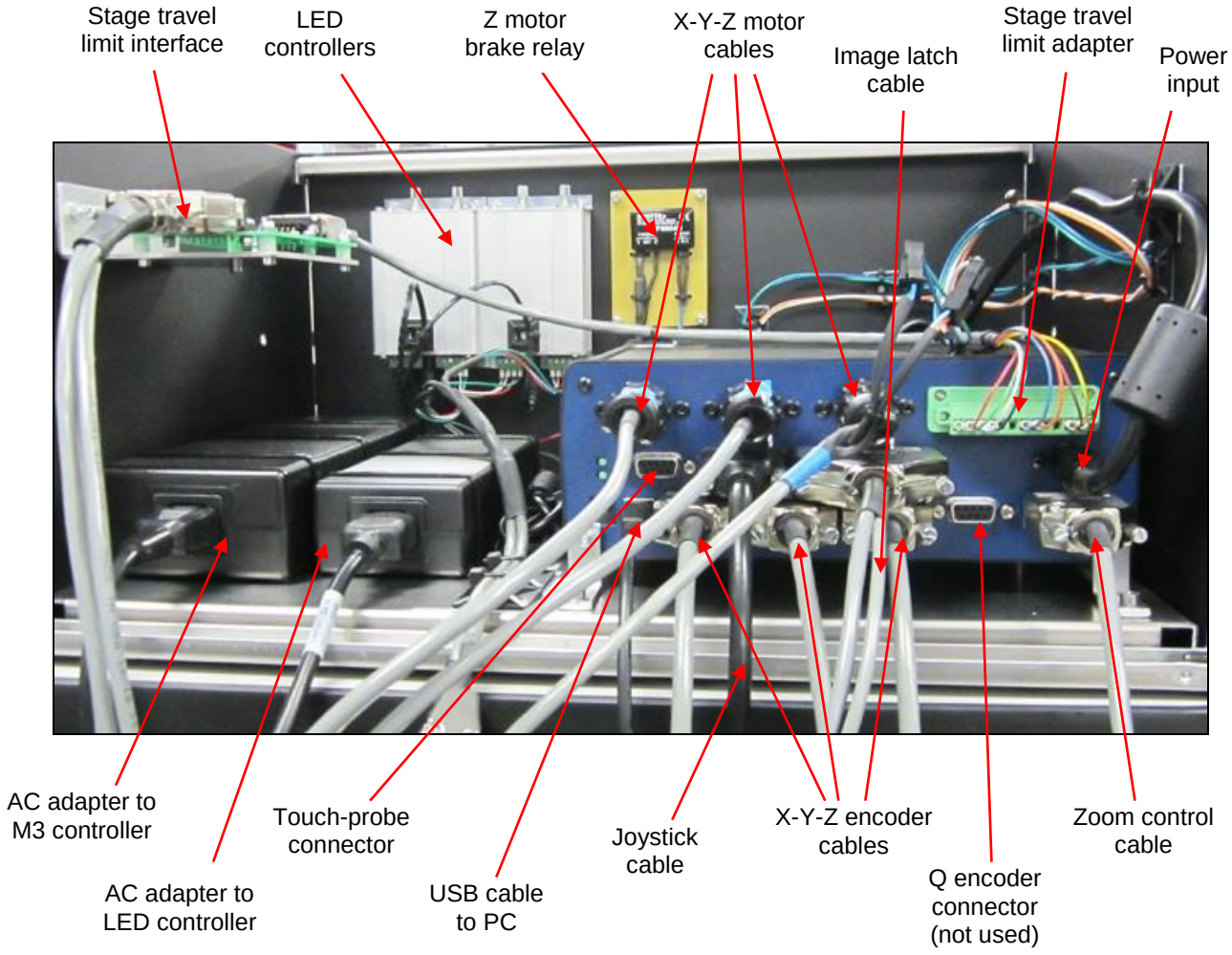
1. After the system has been placed on its pedestal, route the cables from the metrology units through the hole in the pedestal as shown in the photo "Red carrying handle on side of AV350'" on this page.

2. For easier wiring access, pull out the PC and “Amp box” from the pedestal, and remove the top cover from the “Amp box”.

3. With power still removed from the system, start to make electrical connections. Please refer to the diagrams below.



Electrical block diagram (“Amp box” is only used in AV350 and AV450)



Electrical connections to inside "Amp box" of AV350 and AV450

	**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.

5. OPERATION

5.1 Power-on and Power-off

Steps to properly power on the CNC system:

1. Verify that all system components are in the Off position.
2. To apply power to the system PC and M3 controller in AV300 systems, turn on the AC power strip. With an AV350 or AV450 system, rotate the master power switch to the right to the On position (marked by “I” symbol).
3. If the PC of an AV300 system does not automatically turn on, press power button of PC.
4. In AV350 and AV450 systems, turn on the M3 motion controller by rotating the Controller switch to the On position (marked by “I” symbol).
5. From the Windows® 7 startup screen, press on the M3 icon to launch M3 CNC software.
6. Upon launching M3 CNC software, you will be prompted to home the system. Do so, which will establish the “home” or “zero” positions of the X, Y and Z axes.

CAUTION: During the homing sequence and all other CNC operations, follow proper safety protocols, keeping hands and other objects clear of the moving stage. Failure to do so could result in personal injury or equipment damage.

Steps to properly power down the CNC system:

1. Save your work in M3 software.
2. Close M3 software and all other Windows® applications.
3. Using the mouse our touch-screen, click the Start button and on “”Shut down.”
4. After the PC has shut down, remove master power to the system.

5.2 Preparation Steps

Before using the system to measure parts, run the system through the following steps to verify proper mechanical and measurement functions:

1. **Check that the general operating condition guidelines are observed.** See Daily Inspection in the System Maintenance section.
2. **Check lighting controls.** See Lighting Control in the Operation section.
3. **Check stage hardware controls – control knobs or joystick.** See XYZ CNC Stage Control and Image Focus Control in the Operation section.
4. **Check optical zoom.** See Magnification Considerations in the Operation section.
5. **Check parfocality, parcentricity and squareness.** See Optical Alignment Verification in the System Maintenance section.
6. **Check calibration.** See Calibration Verification in the System Maintenance section. In order to validate that the system is in proper working order, take an artifact of known size (such as those on Starrett’s MAG checker), and measure the features utilizing the system controls. Once validated, the system may be used on actual parts.

NOTE: Factory certification can only be provided upon satisfactory of the calibration verification procedures by an authorized representative of the L.S. Starrett Co. Use of your system without proper verification and certification is not recommended.

5.3 C
NC and Manual Control Modes

CNC programmable settings include X-Y stage position, Z-height (for focus adjustment), zoom, and lighting. M3 CNC metrology software is factory configured for AV300 and AV350 systems. Please refer to the separate M3 CNC Software manual.

Stage position can be set manually using the system's joystick and trackball pendant. Please see page 12 of this manual.

Focus can be set manually by rotating the center knob of the joystick.

Zoom and Illumination can be set manually be via the system's touch-screen. Note that image brightness can also be adjusted using the display controls of the all-in-one PC or touch-screen monitor. Not that changing display settings does not affect edge detection (but changing lighting does).

5.4 Operating Considerations

5.4.1 Lighting Considerations

Once the image has been properly focused and magnification has been set, adjust light levels as necessary.

Correct lighting is paramount to accurate measurement with any video-based measurement system. A clear image with lighting toward the low side is recommended. Lighting that is too low will result in a dark, low-contrast image with indiscernible features. Lighting that is too bright will result in a washed-out image that distorts features.

When adjusting lighting, start with light that is lower than desired, and then increase lighting while viewing the image on the monitor. Maintain constant lighting for consistent results. Use the same light level while sampling points for a single feature. Do not to change the light level between points used to measure a circle.

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

NOTE: In order to preserve lamp life and to reduce unnecessary heat in the system, keep the lights turned down when the system is not in use.

5.4.2 Magnification Considerations

Magnification (or zoom) is also important for proper measurements. 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 the edge of a feature by exaggerating edge defects such as burrs or chips. Try decreasing the magnification until the edge is more clearly identifiable.

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 highest magnification that is suitable for the feature being inspected.

5.4.3 Focus Considerations

Accurate measurement requires proper focus of the image. The part image is at best focus when the magnification is highest. It is often preferable to first focus the image at highest magnification, then decrease the magnification to the desired level.

5.4.4 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 "off-the-shelf" Fixturing

6. SYSTEM MAINTENANCE

Your Starrett AV Series CNC Vision Metrology System is designed for years of superior service. Periodic maintenance outlined in this section should be performed regularly to maintain the system in peak operating condition.

- Daily inspection should be performed to ensure that proper safety guidelines are followed and that the system is operating correctly.
- Basic optical parameters should be verified periodically.
- Cleaning and lubrication should be ongoing for proper mechanical and optical operation.
- Lenses, bulbs and fuses should be maintained and replaced as needed.
- Regular factory-authorized calibration and maintenance service should be scheduled to preserve proper function and accuracy.

6.1 Daily Inspections

On a daily basis, the system should be inspected for general safety issues and basic functionality:

- Inspect the area around the system for proper clearance.
- Remove any debris or loose items from around the system and the metrology stage.
- Verify that the work area is clean, dry and free of debris.
- Verify that the electrical power cord is plugged into a grounded power source and is unobstructed.
- Verify that the environmental conditions (temperature and humidity) are within recommended ranges.
- Allow the system to warm up to normal operating temperature before performing critical part measurements.
- Verify that the stage control mechanisms move freely. On CNC Systems, verify through the software that the zoom mechanism also operates freely.

6.2 Optical Alignment Verification

The system's optical alignment should be verified regularly to ensure accurate measurement. Parfocality, Parcentricity and Squareness verification is straightforward and may be performed as often as desired.

NOTE: Optical alignment verification may be performed by any qualified operator. However, optical alignment correction should only be performed by an authorized technician. Report any observed alignment discrepancies and contact the factory or your local representative to schedule authorized service.

6.2.1 Parfocality & Focus

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

Focus, as described in the Operation section, is adjusted by means of adjusting the Z-axis position of the optical system. Therefore, in order to properly inspect parfocality, always reference a flat, sharp edge. Do not select a rough or sloping feature. Starrett's MAG checker is provided with the system and is an ideal part to use in parfocality inspection.

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

6.2.2 Parcentricity

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.

Steps to check parcentricity:

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

6.2.3 Squareness

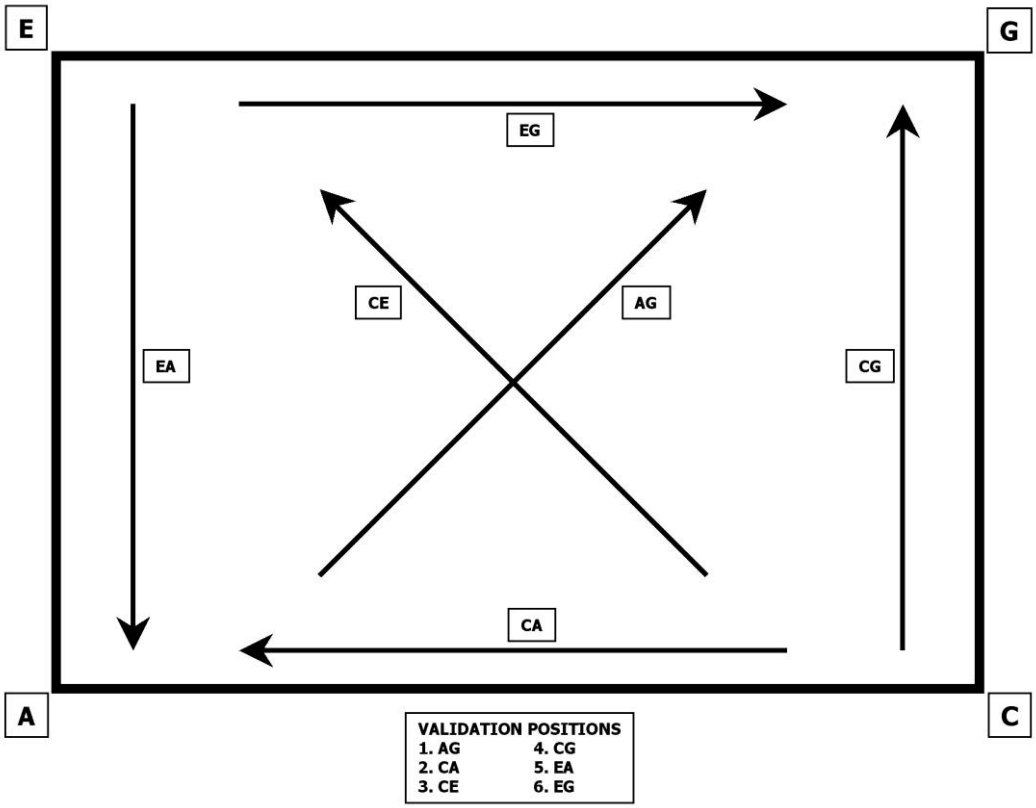
Squareness refers to the alignment of the camera relative to the motion of the metrology stage. If the camera is misaligned (out of square), an image will appear to drift diagonally across the video image as the stage position is moved along one axis.

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 and verify that it is at its defined center position,
3. At low mag, select a point-like feature such as a corner or the standard's X-Y origin. Using the stage, position it to the center of the crosshair.
4. Zoom to high magnification, then refocus and recenter the point as needed.
5. While observing the feature, slowly move the stage X axis ONLY. (Do not move the stage Y axis.) Verify that the point remains aligned on the X axis of the crosshair as the feature is moved to the left and right within the field of view
6. Report any observed discrepancy. If the error is verified, contact your Starrett representative for authorized service.

6.3 Calibration Verification

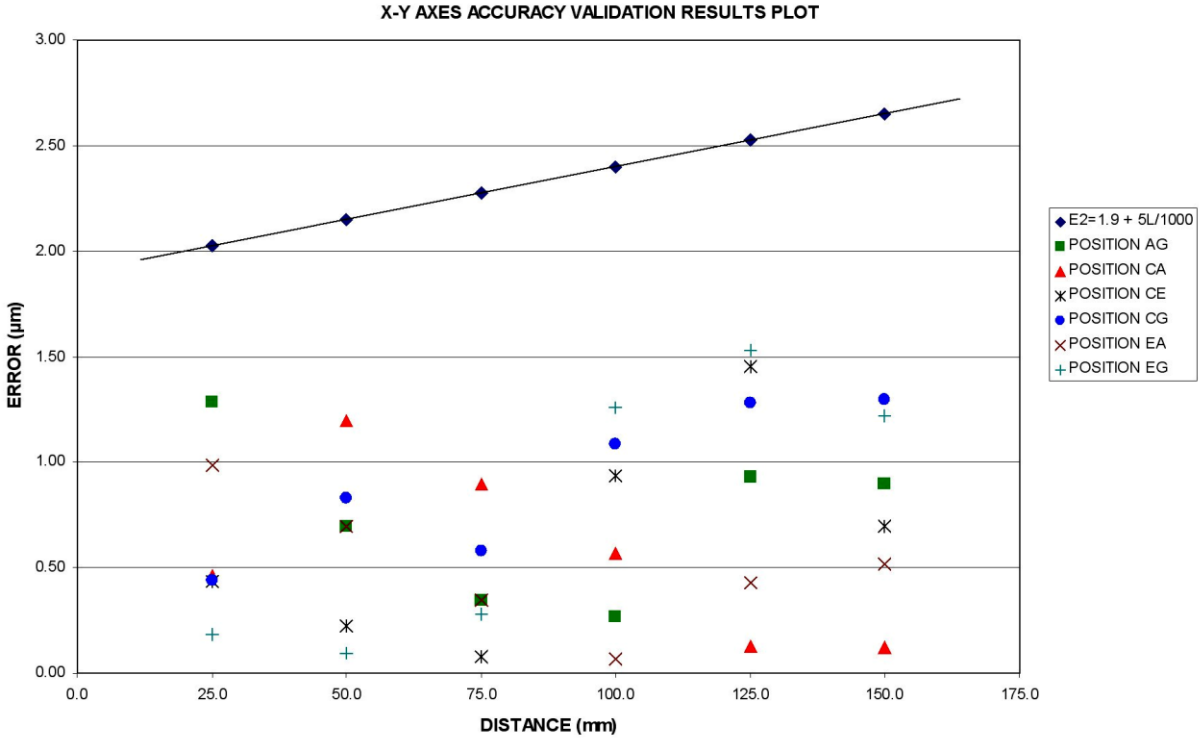
Calibration should be verified periodically depending on user requirements and systems usage, and should be at least monthly. A calibration verification standard artifact is available from Starrett authorized distributors or directly from the Starrett service department. Calibration should also be verified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



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 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 the factory specification, de-rated for the environment and calibration accuracy. See Table 1 - 5, “Travel, Accuracy and Resolution Specifications” for accuracy specifications.



Calibration Error Chart Example

6.4 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 if needed before cleaning the system. Always unplug the system before using any flammable cleaning fluid.

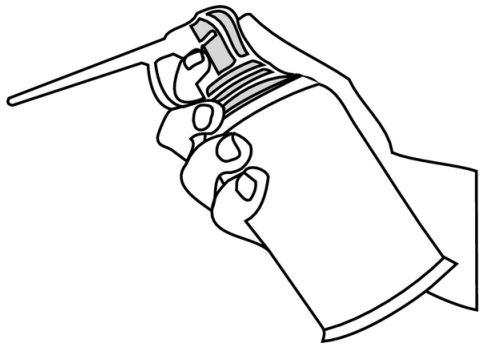
6.4.1 Cleaning External Surfaces

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

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



Optical compressed air

If the lens is soiled with greasy deposits which cannot be blown or brushed off, use an alcohol-based commercial lens cleaner and a lens 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.

6.4.3 Cleaning Mechanical Parts

To ensure a long, trouble-free service life, wipe down the system regularly to remove any dust or dirt from the system. Most critical components are covered and require no user service. Should the stage or column mechanics require service, please contact your Starrett representative.

6.5 Lubrication

Every 6 months, lead-screws may be lubricated with a small amount of Tri-Flow®. Apply to each screw and traverse the stage or column through the entire range of travel several times to distribute the lubricant. Use a clean soft cloth or paper towel to wipe up any excess.

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

6.6 Auxiliary Lens Replacement (Zoom Lens)

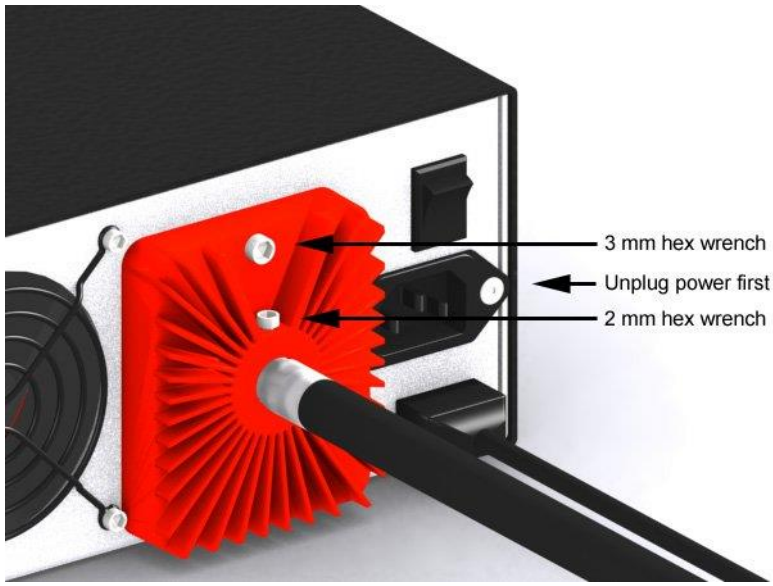
Auxiliary (aux) lenses are available to alter the magnification range of the Manual / CNC zoom lens optics. When changing the auxiliary lens, avoid touching any lens surfaces. No auxiliary lens is required for the standard 1X range of the system.

Steps to change the lens:

1. Remove the ring light prior to changing the lens.
2. If an auxiliary lens is in place, unscrew the lens counterclockwise.
3. Verify the new lens and exposed lens of the primary optics assembly are clean and dust free.
4. Carefully screw in the aux lens clockwise, finger-tight only. Do not over-tighten the lens.
5. Update the lens setting in the QC5000 software. Refer to the QC5000 manual for details.

6.7 Bulb Replacement (Fiber-optic Lighting)

	**NOTE:** The lights of a fiber-optic metrology system generate heat. To preserve lamp life and reduce unnecessary heat buildup, turn the lights down when the system is not in use.
	**WARNING:** Power the system down properly and unplug the unit from the power supply before opening the electronics enclosure.
	**CAUTION:** The lamp bulbs are very hot and can cause burns if not allowed to cool properly. Do not touch any part of the new bulb when inserting. The inner reflective surface of the lens and the filament housing are particularly susceptible to damage. Oils from fingers and hands can contaminate the surface and shorten the bulb life. Use a clean cloth or tissue, or wear clean latex gloves to handle the new bulb. Do not to get any part of a tissue or cloth caught in the bulb contacts to avoid a potential fire hazard. The bulb must be fully seated in the socket to prevent arcing and premature failure of the bulb and damage to the socket.

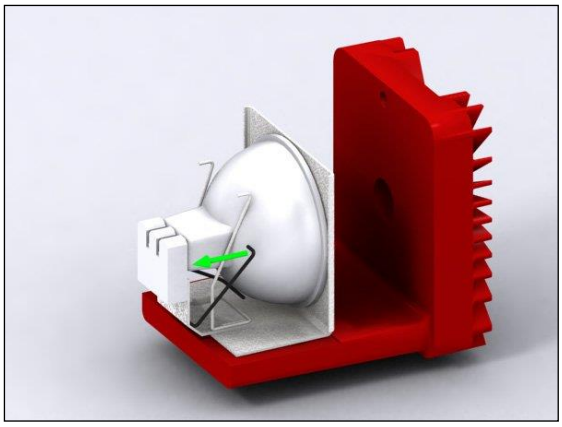


Remove Bulb Housing

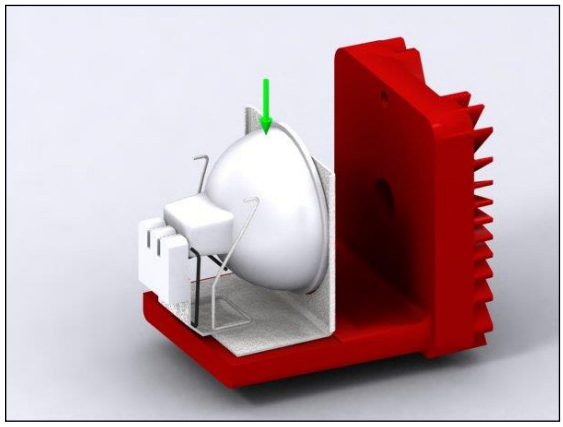
Steps to replace the bulbs:

1. Verify which lamp needs to be replaced before powering the system down. The lamp sockets are labeled TOP, BOT and AUX corresponding to the three system lights.
2. Properly power the system down and unplug the unit from the power source.
3. Using a 2 mm hex wrench, loosen the light bundle retaining screw and remove the light bundle from the heat sink.
4. Using a 3 mm hex wrench, remove the heat sink / enclosure cover retaining screw.
5. Allow the bulbs to cool completely before removing the old bulb.
6. Using the ejector lever as shown, push the old bulb out of its socket.
7. Remove the old bulb by hand when the pins have cleared the socket.

8. Taking care not to touch the new bulb with bare hands, place the bulb in the socket.
9. Firmly push down as shown until the lamp pins are securely seated in the socket. The ejector lever will move back into the closed position when the bulb is fully seated.
10. Replace the cover and properly tighten the retaining screws.
11. Plug the unit in and power the system on to check proper bulb function.
12. If further assistance is required, please contact your Starrett dealer or the factory.



Eject Bulb



Insert New Bulb

6.8 Periodic Calibration and Maintenance Service

It is recommended that Starrett's vision metrology systems and multi-sensor vision metrology systems be serviced and calibrated a minimum of every six (6) months to ensure proper function and accuracy. Under heavy usage conditions, it may be necessary to service the system more frequently. Please contact Starrett an authorized Starrett technician for this service.

7. GLOSSARY

The following terms may have additional meanings. The definitions that follow are in context of the Starrett Vision Metrology Systems.

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

Auxiliary Lens — An accessory lens that may be attached to zoom optics to increase magnification or increase the field of view.

AV — Automatic Video, an alternative designation for “CNC.”

Axis — A direction which allows movement and along which dimensions can be measured. In Manual and CNC metrology systems, three mutually-perpendicular axes are X (left to right), Y (front to back), and Z (bottom to top). Measurement along the X and Y axes is accomplished by moving the metrology stage horizontally. Measurement along the Z axis is accomplished by moving the camera and optics vertically, rather than moving the metrology stage.

Blooming — A condition where the parts of the video image are distorted by oversaturated bright regions so objects can be measured larger than they really are. To avoid blooming errors, observe the video image as you decrease illumination.

CCD — Charge Coupled Device. The solid-state image sensing element of a video camera.

CNC — Computer Numeric Control. In CNC metrology systems, motion of the stage and optics is both motorized and computer controlled, making these system suitable for repetitive measurements in a production environment. Non-CNC system may also be motorized; control will be manual by an operator.

Coaxial Light — A light source that is on the same axis as the camera. Surfaces that face the camera are illuminated brightly, while surfaces angled even slightly away appear much darker. The result is a high-contrast lighting that can help sharpen edges for better detection by the Video Probe. By comparison, light that is not coaxial and shines from different directions (such as from the Ring Light) results in lower image contrast.

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.

E-Stop — Emergency Stop. A switch with cuts power to the motors. An important safety feature.

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 that the camera sees and displays in the video image. “FOV measurement” refers to a measurement that can be done in a single field of view without moving the stage or camera.

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.

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

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

Pixel A picture element. Term used to describe the individual light detectors of a CCD sensor and the individual light emitters of a video monitor. The spacing and number of pixels determines the resolution of a video metrology system.

Parcentricity The condition where a feature remains 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 guarantee high accuracy.

Ring Light A ring-shaped light source which illuminates the object from the top with even illumination from all sides.

QDF Quad Dark Field. Term used with an optional height-adjustable ring light, where LED intensity is individually adjustable in four quadrants. These adjustments are used for shadow control.

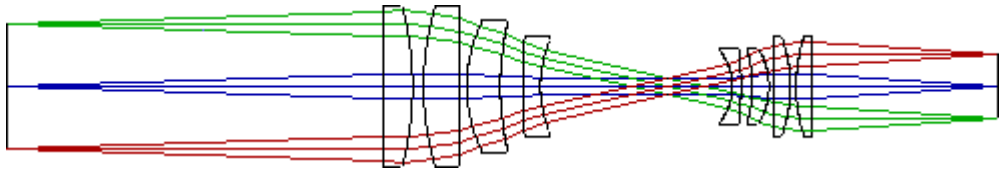
Quad Ring Light A ring-shaped light source where quadrants of LEDs can be individually controlled. This produces illumination from the top and from the sides, with individually adjustable lighting and shadows from the sides. Further control of lighting and shadows from the sides is provided by height adjustment of the quad ring light at the bottom of the video probe to a point 100 mm (or 4”) lower. In AV300 and AV350 systems, the height adjustment is motorized using the system’s Z-Track lead screw feature.

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 Light A light source located below the glass platen of the X-Y stage for silhouette or back illumination.

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 high quality 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.
Z-Track	An optional motorized rail which attached to the video probe assembly to support the optional Quad Ring Light.