AVR400 CNC Video Metrology System
User Guide

www.starrettmetrology.com

October 2024
9985 Revision A

Correspondence regarding this publication should be forward to Starrett Kinematic Engineering by addressing remarks to Technical Support Starrett Kinematic Engineering, 26052 Merit Circle, Suite 103 Laguna Hills CA 92653, USA. Comments about documentation can also be sent through our service website at: https://www.starrettmetrology.com.

Starrett Kinematic Engineering is an ISO 9001:2015 and ISO 17025 accredited company.

ACCREDITED
CERT #6274.01

AMTIVO
ISO 9001
Certified
Quality Management

Table of Contents

1. About This Guide....5

1.1 Purpose....5
1.2 Scope....5
1.3 Audience....5
1.4 Prerequisites....5
1.5 Conventions....5
1.6 Warranty....6
1.7 Disclaimer of Liabilities....6
1.8 Copyright and Trademark Information....6
1.9 Related Production Information....6

2. Environmental and Safety Information....9

2.1 Environmental Conditions....9
2.2 Safety Considerations....9

3. The AVR400 System....13

3.1 Overview....13
3.2 Features and Capabilities....13
3.3 AVR Configurations and Options....14
3.4 AVR System Components....15
3.4.1 X-Y Stage....15
3.4.2 Z-Column....15
3.4.3 Motorized Z-Track....15
3.4.4 MetLogix M3 Metrology Software....16
3.4.5 Lens Options....17
3.4.6 Lighting Control....17
3.4.7 Touch Probe Option....18
3.4.8 Rotary Stage Option....19
3.4.9 Operator Controls and Interfaces....20
3.4.10 Workstation....21

4. System Specifications....23

4.1 Performance Specifications....23
4.2 Hardware and Mechanical Specifications....23
4.3 Electrical Specifications....24
4.3.1 Electrical Power....24
4.4 Optical Specifications....25
4.5 Computer and Software Specifications....26
4.6 Touch Probe Specifications....26
4.7 Rotary Stage Specifications....27
4.8 Workstation Specifications....29

5. Installation and Setup....31

5.1 Planning the Placement of Equipment....31
5.2 Moving the Crated System....31
5.3 Uncrating and Moving the System....32
5.4 Removing Shipping Locks....33
5.5 Setting Up the System....35
5.6 On-Site Installation, Calibration and Training....36
5.6.1 Contacting Starrett Kinemetric Technical Support....37

6. System Operations....39

6.1 Powering On the System 39
6.2 Manually Controlling the System 40
6.3 Verifying Basic M3 Software Operations 42
6.4 Operating the Workstation 42
6.5 Fixturing Parts 43
6.6 Accessing System Electronics 43

7. Understanding Measurement Strategy 45

7.1 Zoom Optics Measurement Strategy 45
7.2 Telecentric Lens Measurement Strategy 45
7.3 Illumination Strategy 46
7.4 Focus Strategy 46
7.5 Verifying the Setup of the System 46

8. Maintaining the System 49

8.1 Performing Daily Inspections 49
8.2 Weekly Inspections 49
8.3 Monthly Zoom Optics Alignment Verification 49
8.3.1 Zoom Optics Parfocality and Focus 50
8.3.2 Zoom Optics Parcentricity 50
8.3.3 Zoom Optics Squareness 51
8.4 Monthly Calibration Verification 52
8.5 Cleaning 53
8.5.1 Cleaning External Surfaces 54
8.5.2 Cleaning Optics 54
8.5.3 Cleaning Critical Mechanical Parts 54
8.6 Spare Parts and Accessories 55

9. Glossary 57

1. About This Guide

1.1 Purpose

This guide provides instructions on how to install, operate, and maintain the AVR400 CNC vision metrology system. This guide also provides information on the various options and features available with the system.

1.2 Scope

This guide provides detailed information about components, features, and specifications of the AVR system. This guide also includes operating and maintenance information for the system. High-level information is provided on unpacking and installation. AVR 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.*

Small Form Factor PC

Throughout this manual, the small form factor PC that is including with the AVR systems will be referred to as system PC.

1.6 Warranty

Starrett Kinemetric 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 Kinemetric Engineering, Inc. (for example, computers, monitors, etc.) carry the original manufacturers' warranty. Starrett might also process warranty for these parts.

Starrett Kinemetric 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

AVR400™ is a trademark 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 AVR systems.

AVR400 Vision Metrology System Unpacking Instructions

These instructions provide the unpacking instructions for the AVR400 system.

2. Environmental and Safety Information

This section provides the environmental and safety information for the AVR400 system.

2.1 Environmental Conditions

Operating Conditions

The AVR system 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.

Before performing critical parts measurements, allow the system to warm up for 30 minutes and use the system's joystick to cycle the X, Y and Z axes ten times.

Factory Calibration Conditions

The AVR system is 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 Safety Considerations

General Safety

The AVR system is 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

The AVR system does 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

- The AVR system weighs 330 pounds (150 kg) and is heavy. To avoid injury, use a lifting device to move the system.
- Motion of the metrology unit is motorized. Motion can be under full computer control or simply under joystick and trackball control with the computer turned off. There are pinch points. Do not place your hands or mechanical items at or near pinch points.

System Emergency Stop

The red button located on the top of the joystick is an emergency stop switch. Refer to the following figure. Refer to the following table for the functionality of the emergency stop switch.

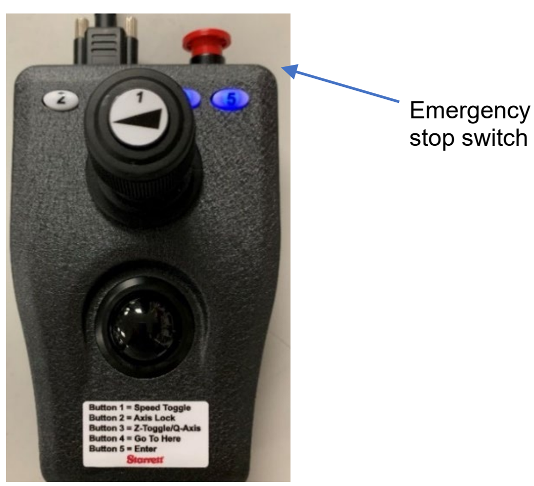


Figure 1. Joystick Emergency Stop Button

If the emergency stop is…	While	Then…
Engaged	The M3 software is performing the auto-homing sequence	All motion will cease, and a dialog box will display the following message: “An error occurred while auto homing. Measurements will be compromised.”
Disengaged	The M3 software is performing the auto-homing sequence	Nothing further will happen. The system will resume normal functions, and the auto-homing sequence will need to be re-run.
Engaged	While an M3 program is running	All motion will cease, and a dialog box will display the following message: “The program has been interrupted [SIC] by a hardware error? A CNC E-Stop error occurred. An E-Stop Error occurred on axis 1. An E-Stop Error occurred on axis 2. An E-Stop Error occurred on axis 3.”
Disengaged	While an M3 program is running	The system will resume normal functions, and the program will need to be re-run from the start. Any data collected before the Emergency stop was engaged will be saved and can be viewed/exported as normal.
Engaged	When a user attempts to run a program	All motion will cease, and a dialog box will display the following message: “The program has been interrupted [SIC] by a hardware error? A CNC E-Stop error occurred. An E-Stop Error occurred on axis 1. An E-Stop Error occurred on axis 2. An E-Stop Error occurred on axis 3.”

If the emergency stop is…	**While**	**Then…**
Disengaged	When a user attempts to run a program	Nothing further will happen. The system will resume normal function

3. The AVR400 System

This section provides the following information:

- An overview of the AVR system
- A description of the features and capabilities of the AVR system
- A description of the configuration options
- A description of the major components of the AVR system

3.1 Overview

The AVR400 system provides a comprehensive CNC metrology solution for dimensional measurement and inspection applications where high accuracy, extended travel, and a stable base for multi-sensor measurements are required. With a stage travel of 400mm x 300mm x 200mm (15.8 x 11.8 x 7.9 inches) in the XYZ axes, this is the largest benchtop platform to date from Starrett. In addition, stage travel speed has also doubled from previous systems, with a travel speed capability of up to 120mm/sec.

3.2 Features and Capabilities

The AVR systems include the following features and capabilities:

- Full CNC XYZ positioning or motorized manual positioning using a pendant with joystick and track ball.
- MetLogix M3 software.
- Video Edge Detection.
- Pattern recognition capability for automated inspection.
- Touch probe compatible for optional multi-sensor capability.
- LED substage and ring light illumination.
- Granite base.
- Includes the option for a 1.6 megapixel (MP) or 2.0 MP color video camera.
- Metrology performance is provided by linear encoders with 0.1 micron resolution and by precision optics, which can be 12:1 motorized zoom optics, manual 6.5:1 zoom optics, or numerous telecentric lenses for accurate field-of-view (FOV) measurements.
- 24-inch touch screen monitor and small form factor PC (system PC).
- Ergonomic workstation and easy to use operator controls.
- Optional rotary stage that provides increased workpiece holding versatility.

3.3 AVR Configurations and Options

There are several options available for AVR400 system. Refer to the following table for a description of the various options.

System	Options
AVR400	• 1.6 megapixel color video camera • 12:1 continuously adjustable motorized zoom optics. • Two-channel LED illumination (ring light, collimated sub-stage lighting, and coaxial lighting)
AVR400 FOV	• 2 megapixel color video camera • Bayonet lens mount that accepts a 6.5:1 manual zoom lens • Telecentric lenses with the following magnifications: 0.3X, 0.5X, 0.8X, 1.0X, 2.0X, 4.0X • Two-channel LED illumination (ring light and collimated sub-stage lighting)
Options	• Auxiliary zooms lenses: 0.5X, 1.5X, 2.0X • Touch probe • Dark field quad light with adjustable height • Optional machine base with height adjustment and anti-vibration damping • Rotary stage
Accessories	• Calibration standards • Calibration grids • Magnification checkers For more information on available accessories, refer to "Spare Parts and Accessories" in Section 8.

3.4 AVR System Components

The following information describes the key components of the AVR400 system.

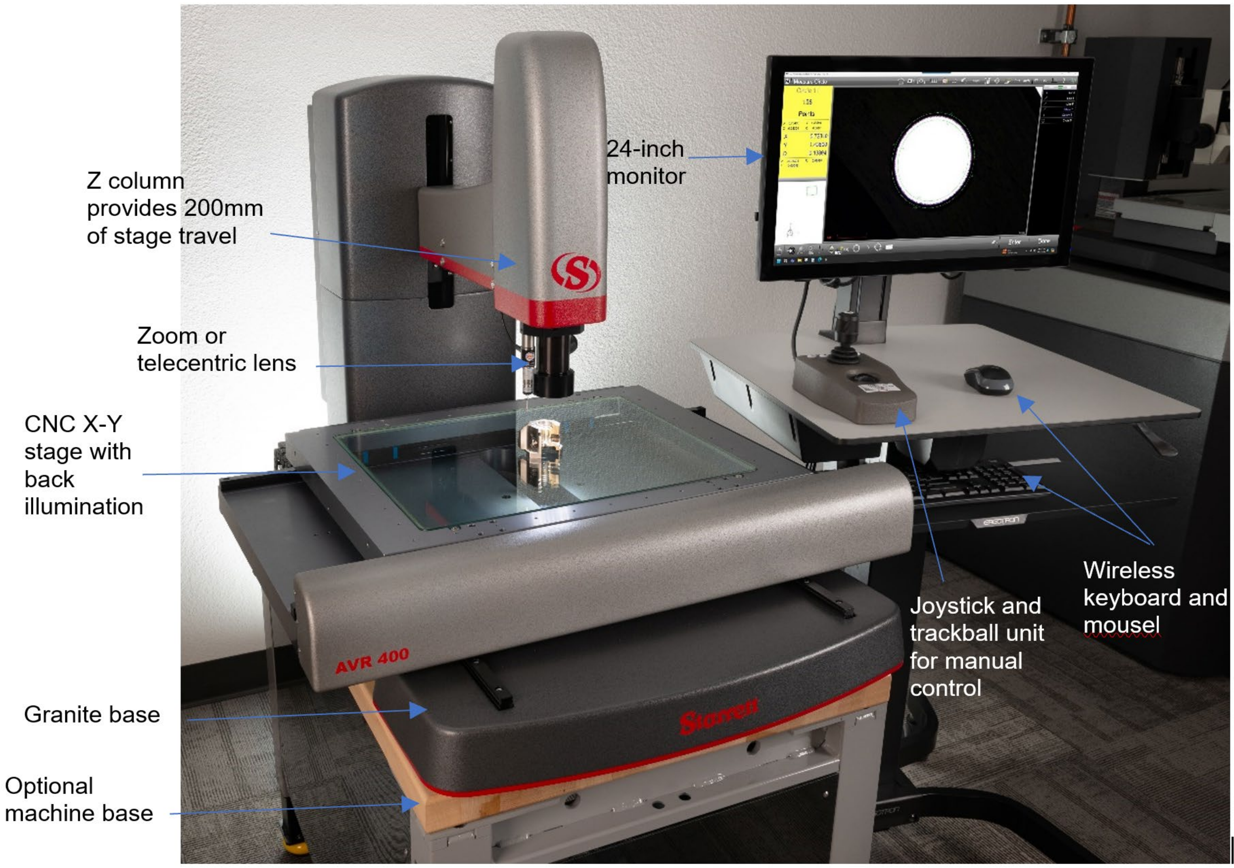


Figure 2. AVR400 System Components

3.4.1 X-Y Stage

The AVR400 offers a measurement range of 400 x 300 x 200 millimeters (15.7 x 11.8 x 7.9 inches). The stage is made from precision machined aluminum on a granite base. Surface mounting holes allow customer-designed fixtures for part support. Stage motion is by means of a stepper motor.

3.4.2 Z-Column

A precision aluminum column supports the touch probe (optional), fixed ring light (standard), coaxial light (optional), and height-adjustable motorized quad ring light (optional). Height adjustment is 200 millimeters (7.9 inches) to accommodate tall parts. Motion along the Z-axis is by means of a stepper motor.

3.4.3 Motorized Z-Track

A motorized Z-track enables height adjustment of the quad ring light. Z-track height is adjusted through the M3 software. Height adjustment is approximately 15 centimeters (5.9 inches).

Figure 3. Motorized Z-Track with Mounted Quad Ring Light

3.4.4 MetLogix M3 Metrology Software

The AVR 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

To maximize versatility, the AVR400 systems provide numerous lens options including 6.5:1 and 12:1 zoom optics and telecentric lens options from .30x to 4.0x.

- The telecentric lenses that provide micron-level resolution and optical distortion as low as 0.001% across the field of view (depending on the lens) for accurate field-of-view (FOV) measurements.
- Zoom optics provide continuous zoom from 0.40X to 4.7X. Utilize zoom optics to measure large parts which would not fit into a single FOV. Zoom optics are also beneficial for smaller parts where extremely high magnification is required.

3.4.6 Lighting Control

AVR400 systems include LED-based lighting control. Light is emitted by ultra-bright LEDs mounted directly in the ring light, quad ring light, coaxial light, and collimated sub-stage light. The output of each light source is controlled through an LED controller and the M3 software. The following information provides additional detail the light source options.

Figure 4. 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 previous figure illustrates the 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 5. Quad Right Light

3.4.7 Touch Probe Option

AVR systems are available with an optional touch probe that is fully integrated into the MetLogix M3 software. The touch probe is ideal to measure the height of flat surfaces or the lateral position of vertical surfaces at different heights as well as 30 features such as cylinders, spheres, and cones. The following figure illustrates the touch probe with the ring light and quad ring light options.

The touch probe kit consists of the following components:

- Renishaw PH6 probe head
- TP20 probe body
- Standard force (SF) probe module
- TP20 medium force (MF) probe module
- 20 mm long stylus with 2 mm ruby tip

  ***Note**: Additional styluses are available from SKE.*

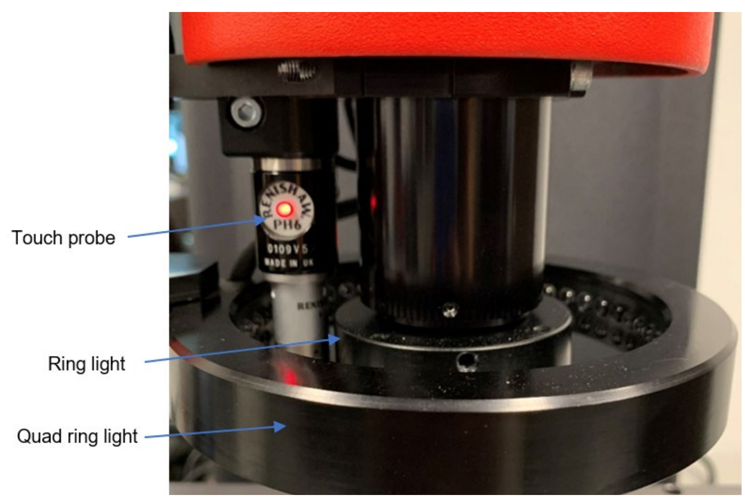


Figure 6. Touch Probe Option

3.4.8 Rotary Stage Option

AVR systems include the APT60 rotary stage option. The 60 millimeter rotary fixture includes the encoder, M3 interface kit, motion amplifier, collet set and right-angle mounting fixture. The rotary stage includes options for a 25 millimeter or 40 millimeter collet set.

The rotary stage provides the following capabilities:

- Compatible with MetLogix M3 software
- Great for positioning small cylindrical parts (shafts, cutting tools, threaded parts)
- Operates at a maximum speed 10 rpm
- Includes an axial load rating of 6.0 kilograms (Kg) and a radial load rating of 0.5 Newton meters (Nm)
- Includes a 2.25-inch diameter circular face
- Provides encoder resolution to 0.001 degrees
- Provides rotational accuracy of ±5 arc minutes
- Includes options for a 25 millimeter or 40 millimeter collet set:
    - The 25 millimeter collet set holds parts up to 5/8 inches in diameter
    - The 40 millimeter collet set holds parts up to one inch in diameter
- Includes a 90-degree mounting bracket

The following figure illustrates the rotary stage with the collet set. For detailed specifications on the rotary stage, refer to “System Specifications” later in this document.

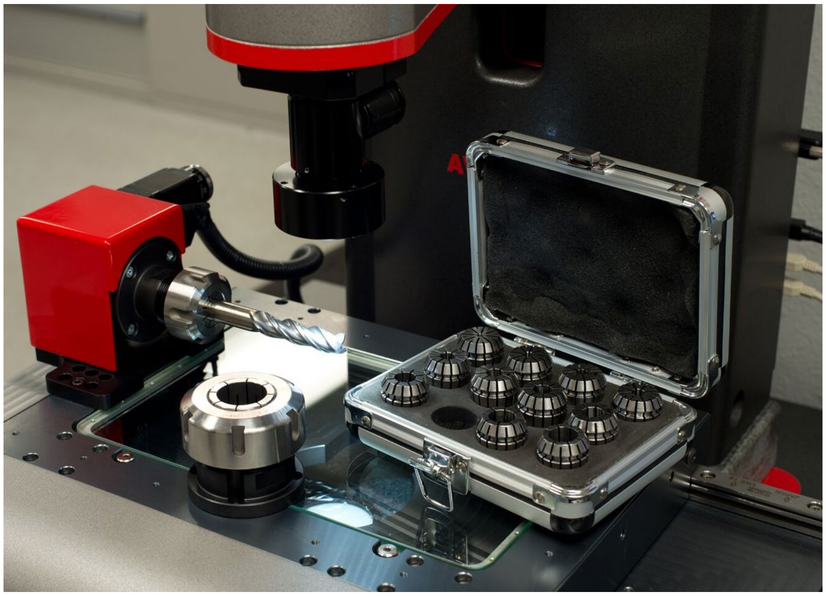


Figure 7. Rotary Stage Option

3.4.9 Operator Controls and Interfaces

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

System PC

The AVR systems includes a small form factor PC where the 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.

Joystick

The joystick provides position control of the stage in the X, Y, and Z axes. The joystick includes functionality to stop the system, switch between axis movement, and control speed. The joystick can be used to operate the system manually for quick individual measurements and short runs.

For detailed information on operating the joystick, refer to “System Operations” later in this document.

3.4.10 Workstation

The AVR400 system include the option for an adjustable workstation. The workstation includes height adjustment and anti-vibration damping capabilities. The following figure illustrates the workstation. Refer to "System Specifications" later in this document for detailed information.

Figure 8. AVR Workstation Option

4. System Specifications

This section provides the specifications for the various components of the AVR400 system.

4.1 Performance Specifications

The following table provides the performance specification for the AVR400 system.

Feature	Description
Measurement range (X-Y-Z)	400 x 300 x 200 mm (15.7 x 11.8 x 7.9 in.)
E2 accuracy (X and Y)	2.5 µm + L/200
E1 accuracy (Z)	2.5 µm + L/200
Scale resolution, X-Y-Z	0.1 µm

4.2 Hardware and Mechanical Specifications

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

Feature	
Unit Dimensions, H × W ×D	915 x 1016 x 1118 mm (36 x 40 x 44 in)
Metrology Base	Granite
Motion Control	Motorized X, Y, Z
Substage Illumination	LED illumination matched to camera optics
Surface Illumination	LED ring light, quad ring light, coaxial light
Operator Controls	Touch-screen monitor, wireless keyboard, wireless optical mouse, pendant with joystick and trackball for manual control.
Optics Mount	Fixed mount for 1.3 MP camera, bayonet mount for 2 MP camera

The following figure provides the dimensions of the AVR400 system.

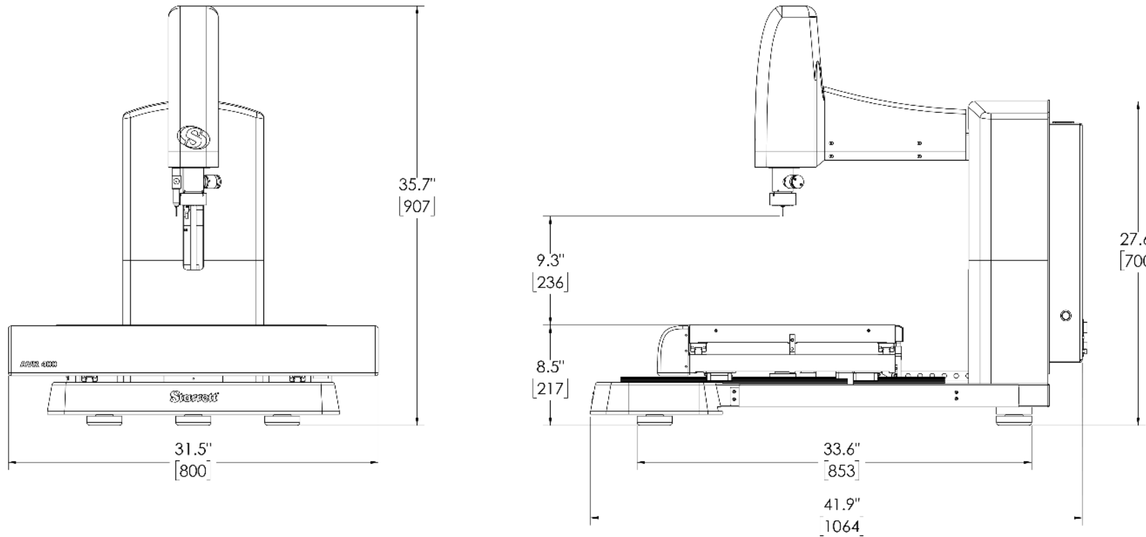


Figure 9. AVR400 Dimensions

4.3 Electrical Specifications

The following table provides the electrical specifications for the AVR400 system.

Feature	**Specification**
Voltage requirement	120/240 VAC
Power requirement	1200W peak, 200W typical
Power Supplies	External AC power adapter, 100/240 VAC, for metrology unit and PC

4.3.1 Electrical Power

The AVR400 system is powered by an external power adapter. The following table provides the specifications of the AC adapter.

Feature	**Specification**
Output	48 VDC output
Voltage requirement	100/240 VAC power for worldwide us
Maximum combined current draw	10.0A at 120 VAC 5.00A at 240 VAC

The power adapter is normally placed on the floor. Before doing so, verify that the floor will never be flooded or hosed down for cleaning. If there is danger of contact with water on the floor, place the adapters in a higher, protected location.

4.4 Optical Specifications

The following tables provide the optical specifications for the AVR system.

Camera

Feature	**Specification**
Camera Resolution	• 1.3 MP (1024 x 768 pixels) with motorized zoom optics • 2 MP (1620 x 1236 pixels) with telecentric optics or manual zoom

Telecentric Optics

Telecentric Optics, Fixed	**0.3**	**0.5**	**0.8**	**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 0.55 in.	8.9 mm 0.35 in.	7.0 mm 0.27 in.	3.5 mm 0.14 in	1.8 mm 0.07 in.
Field of View Height	19 mm .76 in.	11 mm .45 in.	7.4 mm .29 in.	5.6 mm .22 in.	3 mm .12 in.	1.5 mm .06 in.
Telecentric Working Distance	110mm (4.3 in.)					
Camera CCD	1/1.8 in.	1/1.8 in.	1/1.8 in.	1/1.8 in.	1/1.8 in.	1/1.8 in.

Zoom Optics

Zoom Optics	**6.5:1 Zoom**	**12:1 Zoom**
Magnification on CCD	0.47X to 3.0X	0.40X to 4.7X
Magnification on Monitor*	31X to 198X	26X to 310X
Field of View Width	10 to 1.6 mm 0.39 to 0.06 in.	12 to 1 mm 0.47 to 0.04 in.
Field of View Height	8.1 to 1.3 mm 0.32 to 0.05 in.	10 to 0.76 mm 0.39 to 0.03 in.
Zoom Working Distance	88 mm (3.47 in.)	88 mm (3.47 in.)
Camera CCD	1/1.8 in. (2 MP)	1/3 in. (1.3 MP)
Available Auxiliary Lenses	0.5X, 1.5X, 2.0X	

4.5 Computer and Software Specifications

The following table provides the computer and software specifications for the AVR400 system.

***Note**: Computer and software specifications are subject to change.*

Feature	Specification
Computer Hardware	PC with 16GB RAM and INTEL i5-1335U Processor
Computer interface	24-inch touch screen monitor
Computer Interfaces	Eight USB ports, SATA 3.0, dual M.2 slots, one M.2 E slot, HDMI 2.0b, DisplayPort, VGA.
Operating System	Windows®
Application Software	MetLogix M3 CNC metrology software and DXF/FOV option pack
Geometrical Constructs	2D geometries plus height
Comparison to CAD Files	DXF CAD file import, automatic comparison to CAD files

4.6 Touch Probe Specifications

The touch probe includes the following components and specifications.

- Probe body
- Probe module - seven variants enable numerous applications
- Module changing rack for automatic operation
- Interfaces with Renishaw PI 7-3, PI 200-3 and UCC controllers

Feature	Specification
Sense directions	±X, ±Y, ±Z
Interface	PI 7-3, PI 200-3, UCC controllers
Pre-travel variation	LF: ±0.60 μm (± 0.000023 in) SF / EM1 / EM2: ±0.80 μm (± 0.000032 in) MF: ±1.00 μm (± 0.000039 in) EF: ±2.00 μm (± 0.000079 in) 6W: ±1.50 μm (±0.000058 in)
Unidirectional repeatability	LF / SF / EM1 / EM2: ±0.35 μm (± 0.000014 in) MF: ±0.50 μm (± 0.000020 in) EF: ±0.65 μm (± 0.000026 in) 6W: ±1.00 μm (± 0.0000395 in)
Repeatability of stylus changing	MCR20: ±0.50 μm (± 0.000020 in) Manual: ±1.00 μm (± 0.000040 in)

Figure 10. Touch Probe Option

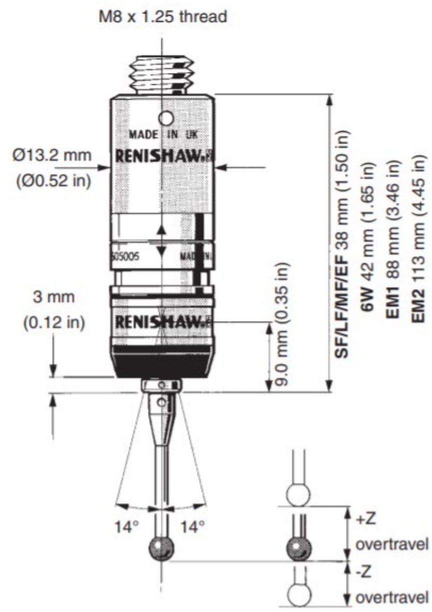


Figure 11. Touch Probe Dimensions and Specifications

4.7 Rotary Stage Specifications

The following table provides the specifications for the rotary stage option.

Feature	**Specification**
Rotational accuracy	± 5 arc minutes
Load capacity, axial	6.0 Kg
Load capacity, radial	.5 Nm
Maximum speed	10 RPM
Runout	10 µm (100 µm with collet set)
Rotary stage weight	2.7 pounds (1.2 kg)

The following figures provide the dimensions of the APT60 rotary stage.

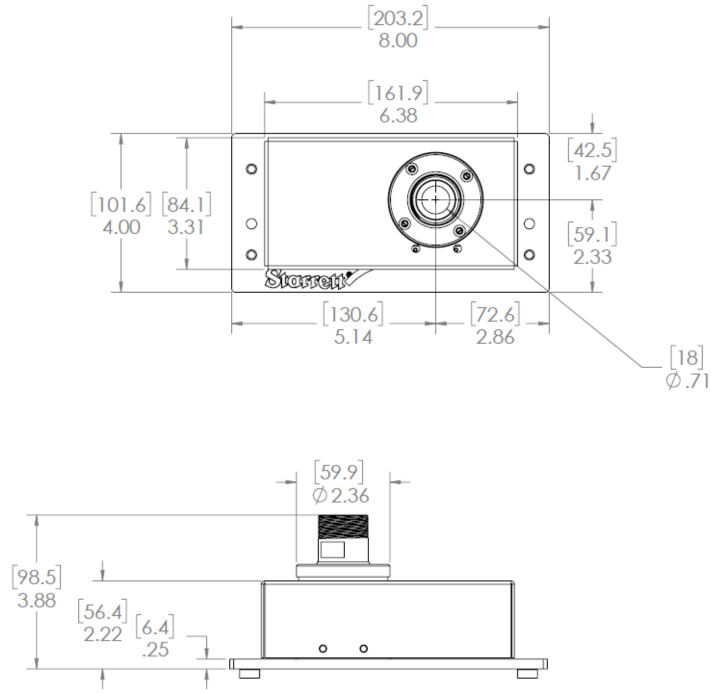


Figure 12. APT60 Rotary Stage in Vertical Configuration

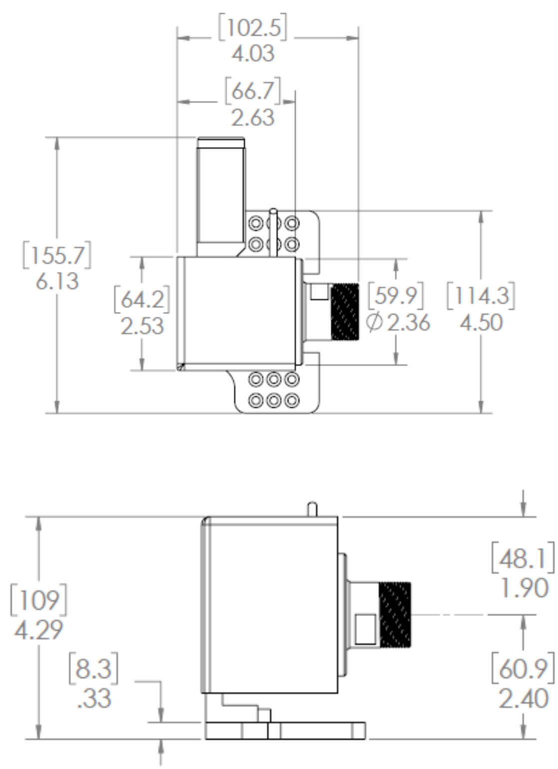


Figure 13. APT60 Rotary Stage in Horizontal Configuration

4.8 Workstation Specifications

The following table provides the specifications for the workstation. The following figure provides the dimensions. For information on operating the workstation, refer to “Operating the Workstation” later in this guide.

Feature	Specification
Workstation width	36 in. (914mm)
Workstation depth	24 in. (610mm)
Workstation height	28.4 in. (721mm)

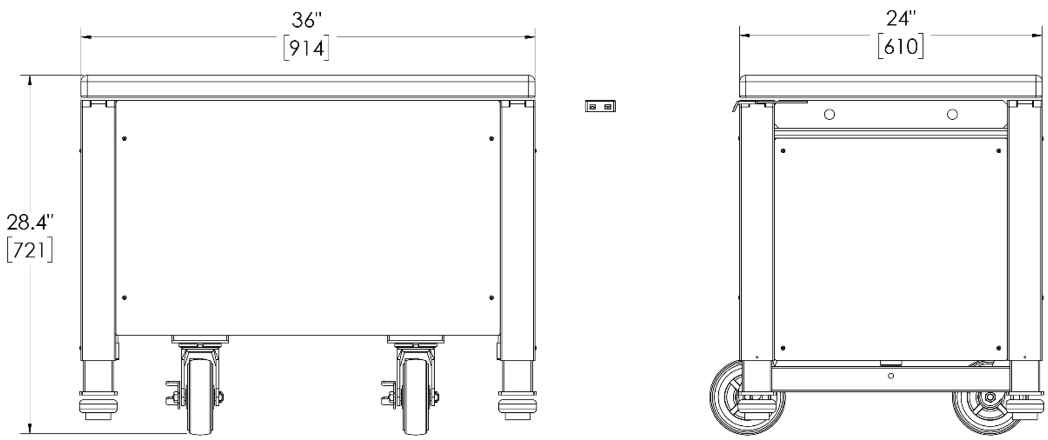


Figure 14. Workstation Dimensions

5. Installation and Setup

This section provides information on unpacking, installing, and setting up the AVR400 system. 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.

5.1 Planning the Placement of Equipment

When planning the placement of the AVR system, 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°C ± 0.5°C (68°F ± 5°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.
    - AVR systems are designed to be installed on a benchtop at a height of approximately 85 centimeters (33.5 inches). The height of the optional workstation can be adjusted to suit the requirements of the operators.
- 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 Crated System

The AVR400 is 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 can damage the contents.

5.3 Uncrating and Moving the System

Tool Requirements

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

- Battery powered drill with Phillips bit (to remove top and sides of shipping crate)
- Crescent wrench (to remove screws which attach shipping tabs to the crate)
- Bubble level (to level workbench or workstation)
- Common hand tools
- Lifting kit (includes lifting straps and hook assembly)

Procedure

To uncrate the AVR 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 15. Removing Screws from the Shipping Container

Moving the AVR System

The AVR system weighs 350 pounds (113 kilograms). It is highly recommended a lifter be used to move the system to the final working location. The AVR shipment includes a Lifter Kit to help with this process. Refer to the ***AVR400 Unpacking Instructions*** for more information on this process.

5.4 Removing Shipping Locks

Background

AVR400 systems are shipped with multiple mechanisms to prevent movement during shipment. Shipping locks are installed on each side of the X-Y stage and on the Z-column of the system to prevent movement during shipment. Refer to the following figure.

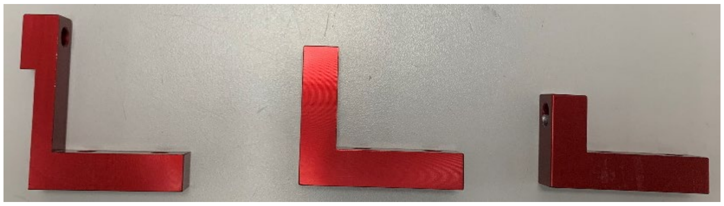
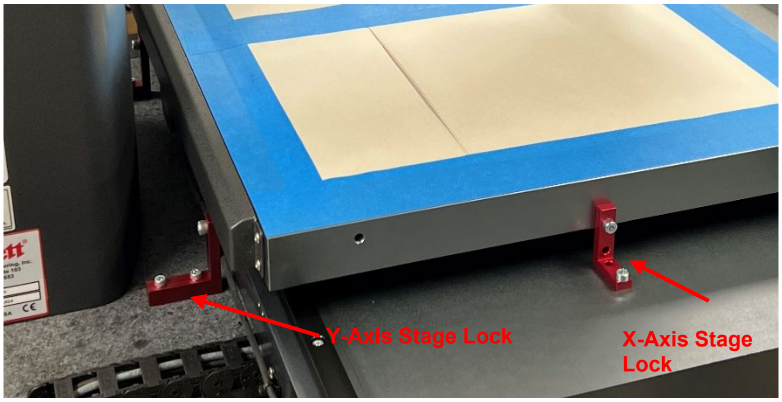


Figure 16. Shipping Locks

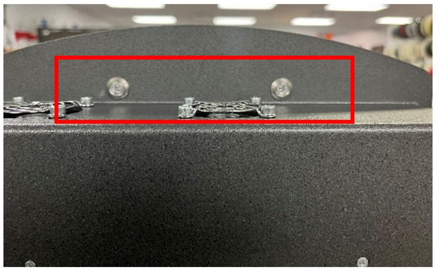
Procedure

To remove the shipping locks, perform the following steps:

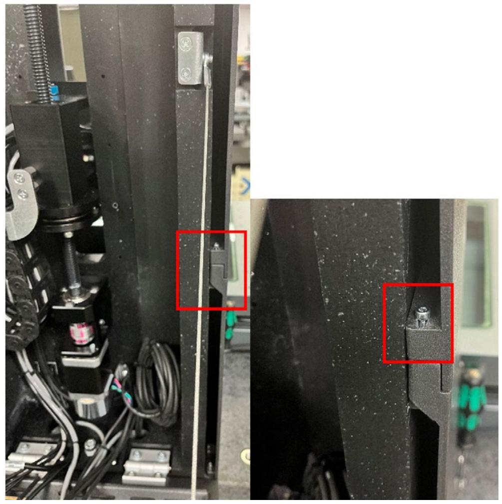
1. Locate the four red locks that secure the stage. There are two locks on each side of the stage and two locks on the rear of the stage. Refer to the following figures.
2. Using a metric hex wrench, remove the two M5 socket head cap screws that secure each lock.



3. To access the remaining shipping locks, do the following:
   a. Using a Phillips screwdriver, remove the two screws at the top of rear panel of the AVR system. Refer to the following figure. The rear panel is hinged.



   b. On the rear panel of the system, locate the two M3 screws on each side of the column. Refer to the following figures.



c. Using a metric hex wrench, remove the M3 screws from each side of the column.

d. From the front of the system, lift the top half of the cover off the system. The cover is magnetized and should lift off easily.

e. Locate the red shipping locks on the Z column. Refer to the following figure.

f. Using a metric hex wrench, remove the two M5 socket head cap screws that secure each lock. Refer to the following figure.

g. Replace the top cover of the system.

h. Reattach the two M3 screws on the rear column.

i. Close the rear panel and reattach the two Phillips screws that secure the panel.

4. Retain the shipping locks for future use.

Figure 17. AVR Z Column Shipping Locks

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 AVR 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.
4. Connect the DB9 connector for the joystick and emergency stop switch to the connector marked “Joystick” on the I/O panel.
5. Connect the remaining end of the cable to the joystick.

Figure 18. AVR Rear I/O Panel Cabling

6. Connect a USB cable to the USB connector marked “M3” on the I/O panel. This cable supports the encoder signals for the M3 software. Refer to the previous figure.
7. Connect the remaining end of the USB cable to a USB connector on front panel of the system PC. Refer to the following figure.

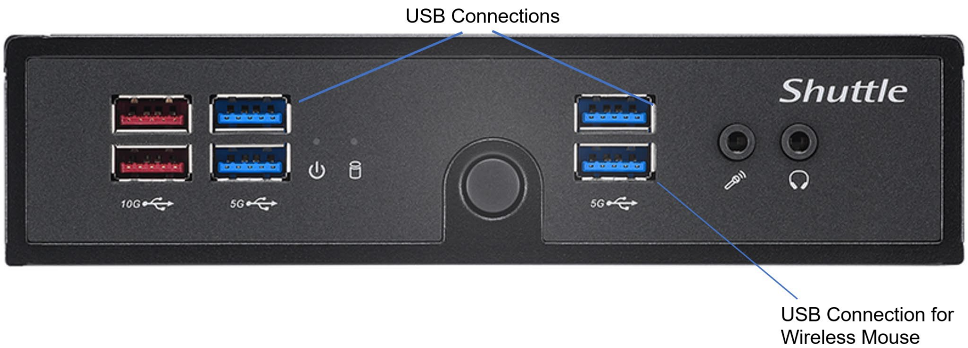


Figure 19. System PC Cable Connections

8. Connect an additional USB cable to the USB connector marked “Camera” on the I/O panel. This cable supports the camera signal.

9. Connect the remaining end of the USB cable to a USB connector on front panel of the system PC. Refer to the previous figure.
10. Connect the HDMI monitor cable to the HDMI port on the rear panel of the system PC.
11. Connect the remaining end of the HDMI monitor cable to the 24-inch monitor.
12. Connect the power supply cable to the DC In port on the rear panel of the system PC.
13. Connect the remaining end of the power supply cable to an external power source.

Figure 20. System PC Cable Connections

14. On the front panel of the system PC, insert the dongle for the wireless keyboard and mouse. Refer to the previous figure.
15. Ensure both the wireless keyboard and wireless mouse are equipped with batteries.

5.6 On-Site Installation, 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 might have moved during shipment. A complete functional test and calibration are recommended following physical installation.

Professional system installation is normally provided by Starrett Factory Service Technicians or Starrett Authorized Service Technicians for all new vision metrology systems and optical comparators sold in North America. Installation can include equipment setup, on-site calibration and on-site operator training. While professional installation, calibration and training are separately quoted line items, these services are highly recommended and are purchased by most users.

As part of its setup services, Starrett may oversee 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 process typically takes half day for an AVR system. The system should temperature stabilize for 24 hours prior to calibration.

On-site calibration normally takes place following setup. Starrett offers ISO 17025 accredited calibrations. Calibration uses NIST-traceable glass standards and gage blocks. Calibration typically takes half to one day for an AVR system. If a motorized rotary stage is purchased with the AVR system, then additional installation, set-up and calibration is required which can add another two hours of technician time plus the appropriate calibration equipment.

On-site basic operator training can be provided following calibration. This typically takes half day for an AVR 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 they can all get hands-on time. Starrett's objective is to create "power users," who can then train other users when needed.

Technical services in North America (USA, Canada and Mexico) are provided by professional installers and service technicians operating out of the Laguna Hills, CA, headquarters of Starrett Kinemetric, its regional sales offices, and its Starrett Authorized Service Partners. Outside of North America, Technical services are provided by Starrett subsidiaries in Brazil (for South America), Scotland (for Europe and Africa), China (for Mainland China), and Singapore (for Southeast Asia and Australia).

5.6.1 Contacting Starrett Kinemetric Technical Support

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

- Request technical support through our ticketing system.
- Register your system.
- Download User Manuals.
- Access our Starrett Kinemetric 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 AVR systems:

- Powering on the system
- Using the system controls
- Verifying basic M3 software operations
- Operating the workstation
- Using parts fixturing

6.1 Powering On the System

Power Switches

AVR systems have two power switches.

- On/Off rocker switch on the right side of the AVR system. Refer to the following figure.
- Power button on the front of the system PC.

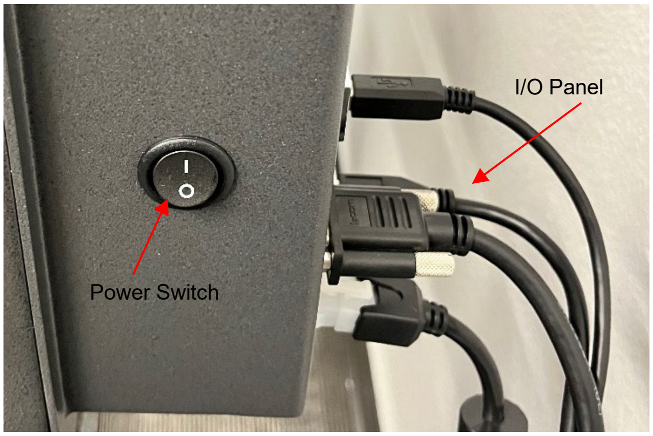


Figure 21. AVR Power Switch

The pendant with the joystick and trackball is powered by the metrology unit. Turn the system off when not in use.

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. Power on the AVR system by pressing the Power On/Off switch on the side of the unit to the "I" position. Refer to the previous figure.
2. Power on the mouse by moving the switch on the bottom of the mouse to the On position.

3. Power on the keyboard by moving the switch on the top of the keyboard to the On position.
4. Power on the monitor.
5. Power on the system PC. Ensure that the system PC boots up properly.
6. Verify that the preinstalled M3 software is functioning properly. Refer to the "Verifying Basic M3 Software Operations" later in this section for additional information.

6.2 Manually Controlling the System

The AVR system can be manually controlled using the joystick. The following table provides the functionality of the joystick. Refer to the following figure for the location of the controls.

Control	**Function**
Emergency stop switch	Press to stop all CNC motion.
Button 1	Speed toggle. Located on the top of the joystick. Press once for slow speed for the control. Press again for normal speed.
Button 2	Axis lock. Press for motion along one axis only. Press again to allows diagonal motion.
Button 3	Z-Toggle. Press for Z-axis control by the trackball. Press again for Z-axis focus control or Q-Axis rotary stage control by the trackball.
Button 4	Go To Here. Press to lock in coordinates when programming.
Button 5	Enter. This button functions the same as the Enter key on a PC keyboard.
Joystick deflect right to left	Moves the stage from right to left (X-axis control).
Joystick deflect front to back	Moves the stage up or down (Y-axis control).
Joystick rotate	Moves the stage in and out (Z-axis focus control).
Trackball	Rotate for fine tuning X and Y positions, or for fine tuning Z-axis focus or Q-axis rotation as set by Button 3.

Emergency Stop switch

Press to stop all CNC motion.

Five pushbuttons:

- **Button 1 =** Speed Toggle. Located on at top of joystick. Press for slow speed for fine control. Press again for normal speed.
- **Button 2** = Axis Lock. Press for motion along one axis only. Press again to allow diagonal motion.
- **Button 3** = Z-Toggle / Q-Axis. Press for Z-axis focus control by trackball. Press again for Z-axis focus control or Q-Axis rotary stage control by trackball.
- **Button 4** = Go To Here. Press to lock in coordinates when programming.
- **Button 5** = Enter. Same as Enter key on PC keyboard.

Joystick:

- **Deflect right to left** to move stage from right to left (X-axis control).
- **Deflect front to back** to move stage up or down (Y-axis control),
- **Rotate** to move stage in and out (Z-axis focus control).

Trackball

Rotate for fine tuning X and Y positions, or for fine tuning Z-axis focus or Q-axis rotation, as set by Button 3.

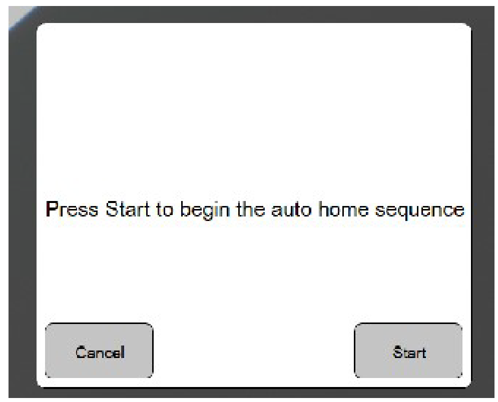
Figure 22. Joystick Functionality

6.3 Verifying Basic M3 Software Operations

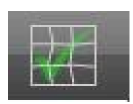
The following information provides basic instructions for operating the M3 software. For detailed information, refer to the ***MetLogix M3 Video and FOV Inspection Software User's Guide*** included with your system.

To start the M3 software, perform the following steps:

1. Ensure the system, PC, and monitor are powered on.
2. Double-click the M3 software icon on the desktop.
   This action displays the interface below.



3. Select Start or touch the Start button on the screen.
   If you have a CNC machine, the X, Y and Z-axis automatically references the machine.
4. 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 Operating the Workstation

The optional workstation can be raised and lowered like a standing desk. Use the paddle-style switch to raise or lower the workstation to the desired height. Refer to the following figure. In addition, the workstation includes anti-vibration mounts with retractable 6" swivel casters that can be raised and lowered.

Figure 23. Raising and Lowering the Workstation

6.5 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 the ***MetLogix M3 Video and FOV Inspection Software User's Guide*** for details.

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

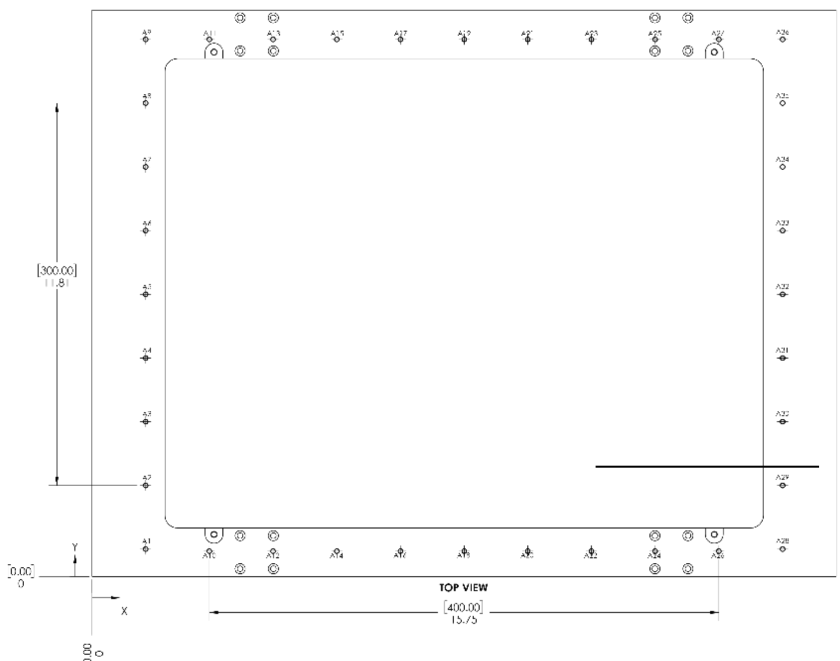


Figure 24. AVR400 Tooling Holes

6.6 Accessing System Electronics

The back of the AVR system is hinged and holds a compartment with electronics and other components of the system. There are no user serviceable parts in this location. Removing the two Phillips screws provides access to this compartment.

7. Understanding Measurement Strategy

AVR systems are available with either 6.5:1 zoom optics with adjustable magnification from 0.47X to 3.0X, with 12:1 zoom optics with adjustable magnification from 0.4X to 4.7X, or with numerous telecentric lens options with a fixed magnification of 0.3X, 0.5X, 0.8X, 1.0X, 2.0X or 4.0X. Magnification is the image size at the camera CCD detector place divided by the object size. Since the CCD size is fixed, each magnification has a corresponding field of view (FOV), which is the CCD size divided by magnification. The higher the magnification, the higher the resolution, but also the smaller the field of view.

AVR optical assemblies are matched to a specific camera. Optical assemblies are not user changeable, but require installation, alignment, calibration, and optimization of substage illumination by a factory trained technician.

The following information discusses the measurement strategy for the available optics.

7.1 Zoom Optics Measurement Strategy

While zoom optics can provide the same field of view (FOV) as four of the telecentric lenses, they do not offer the ultra-low optical distortion that is required for purely optical measurements across the entire FOV. However, they can be more accurate than telecentric lenses when used at high magnification in combination with stage motion, where reading accuracy is based on the system’s calibrated linear encoders.

Select zoom optics to measure the following:

- Large parts that would not fit into a single FOV
- Smaller parts where extremely high magnification is required.

The lowest zoom magnification setting accommodates parts up to 11.2 x 9.4 millimeters (0.44 × 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 ensures that a feature will remain at the optical center of the video image throughout the magnification range.

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 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.

7.2 Telecentric Lens Measurement Strategy

Select telecentric optics to perform high accuracy, high throughput field-of-view (FOV) measurements. If all measurements are to be in the FOV, select the highest magnification lens whose FOV encompasses the entire part. If the entire part cannot fit into the FOV, the stage can be moved up to 400 millimeters (15.7 inches). The M3 software will seamlessly integrate FOV measurements with encoder readings from stage motion.

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 dim 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, and then increase lighting while viewing the image on the monitor. Maintain constant lighting for consistent results. Always use the same light level while sampling points for a single feature – do not to change light levels during a measurement run.

Depending on the part characteristics and the feature being measured, the right combination of lighting can aid in bringing out a particular feature. Take time to experiment by balancing the available light sources. Once the best illuminations settings have been found, illumination should be under full computer control along with CNC motion.

Light Options

The AVR system includes the following LED adjustable lights: ring light, substage light, coaxial light, and quad ring light. The quad ring light is available with manual height adjustment or motorized height adjustment, both over 150 millimeters (6 inches).

7.4 Focus Strategy

Always work at best focus. Focus is determined by adjusting the horizontal Z distance from the lens to the workpiece. Following are guidelines for setting focus:

- To set focus, move the stage from front to back until you find the two points on both sides of the point of best focus where the image just starts to defocus. The point of best focus will be approximately midway between these two points.
- When using zoom optics, first focus the image at highest magnification, then decrease the magnification to the desired level.

7.5 Verifying the Setup of the System

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

1. Check that the operator controls and M3 software are running properly. Refer to “System Operations” earlier in this document.
2. Check the lighting controls. Refer to “Illumination Strategy” earlier in this section.
3. Check the system optics and ensure the optics are appropriate for the measurement being performed. Refer to “Understanding Measurement Strategy” earlier in this section.
4. Check that the general operating condition guidelines are observed. Refer to “Daily Inspection” later in this document.
5. Check parfocality, parcentricity, and squareness. See “Optical Alignment Verification” later in this document.

6. Check calibration. See “Calibration Verification” later in this document. To validate that the system is in proper working order, take an artifact of known size and measure the features utilizing the system controls. Once validated, the system can be used on actual parts.

8. Maintaining the System

AVR vision metrology systems have been designed for years of superior service. Periodic maintenance as outlined in this section is considered good practice to maintain your system in peak operating condition.

8.1 Performing Daily Inspections

Each day, inspect your system for general safety and basic functionality:

- Verify that the work area is clean, dry, and free of debris. Remove any debris or loose items from around the system and metrology stage.
- Verify that the electrical power cords are plugged into a grounded power source and are unobstructed.
- Verify that temperature and humidity are within recommended ranges. Refer to "Environmental Conditions" earlier in this document.

8.2 Weekly Inspections

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

- Verify that the stage control mechanisms move freely. If binding is observed, contact SKE Technical Services for service. The lead screws use a self-lubricating TFE coating, which is designed to last for the life of the product. Do not apply cleaner or lubricant.
- Perform a basic calibration check against a certified chrome-on-glass standard, such as Starrett's magnification (mag) checker, part number 9123. (Refer to "Spare Parts and Accessories" later in this section.) With a telecentric system, perform a single measurement on an artifact whose dimensions are comparable to those of the parts to be measured, and verify that the measured dimensions are within the AVR's specifications. With a zoom system, measure artifacts at the zoom detent positions for maximum and minimum magnification.

8.3 Monthly Zoom Optics Alignment Verification

The system's zoom optics (if part of the system) should be verified monthly for parfocality, parcentricity, and squareness to ensure accurate measurement. Verification is straightforward and can be performed as often as desired.

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

8.3.1 Zoom Optics Parfocality and Focus

Definition

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 their magnification range. To check parfocality, always reference a flat, sharp edge. Do not select a rough or sloping feature. A magnification checker is an ideal part to check parfocality.

Procedure

To check parfocality, perform the following steps:

1. Place the magnification 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 Zoom Optics Parcentricity

Definition

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

Procedure

To check parcentricity, perform the following steps:

1. Place the magnification 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 Video and FOV Inspection Software User's Guide*** for detailed information 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 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), the image will drift diagonally across the screen as the stage is moved along the other axis.

Procedure

To check squareness, perform the following steps:

1. Place the magnification checker or other suitable inspection part on the stage and secure properly.

2. Select the crosshair image tool in software and verify that it is at its defined center position. Refer to the ***MetLogix M3 Video and FOV Inspection Software User's Guide*** for detailed information.

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 Monthly Calibration Verification

While not always strictly necessary, it is recommended that the calibration verification described in this section be performed periodically depending on user experience. A linear calibration verification standard (200mm linear standard) artifact is available from Starrett authorized distributors or directly from the Starrett service department. Refer to “Spare Parts and Accessories” later in this section for additional information. 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.

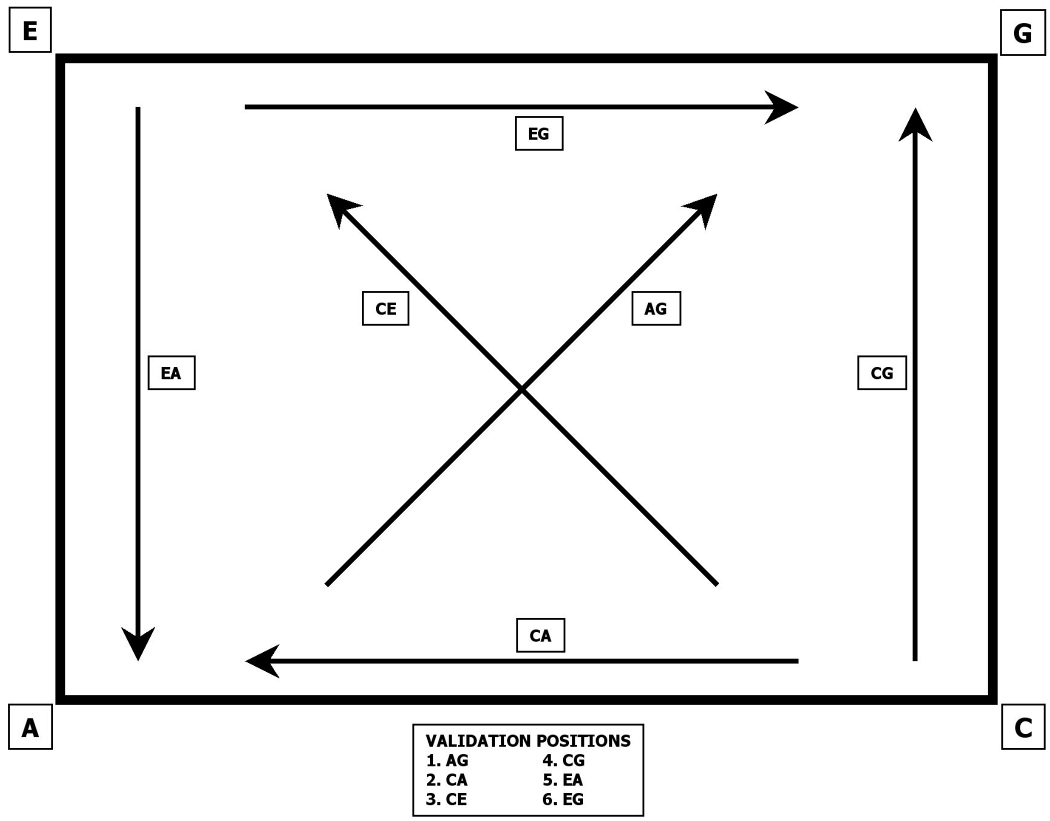


Figure 25. Calibration Verification Standard Placement

To validate calibration, perform the following steps:

1. Place the calibrated verification standard in one the six positions on the glass stage as shown 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 Video and FOV Inspection Software User’s Guide*** for detailed information.

3. Measure the distance between the 1st and 2nd, 1st and 3rd, 1st and 4th, 1st and 5th, and the 1st and 6th fiducials.

4. Repeat these measurements three times.

5. Calculate the absolute average deviation for each of the six groups of distance measurements.

6. Repeat the measurements for all six locations shown in the previous figure.

   The absolute averages should be within factory system specifications and be derated for the environment and calibration errors.

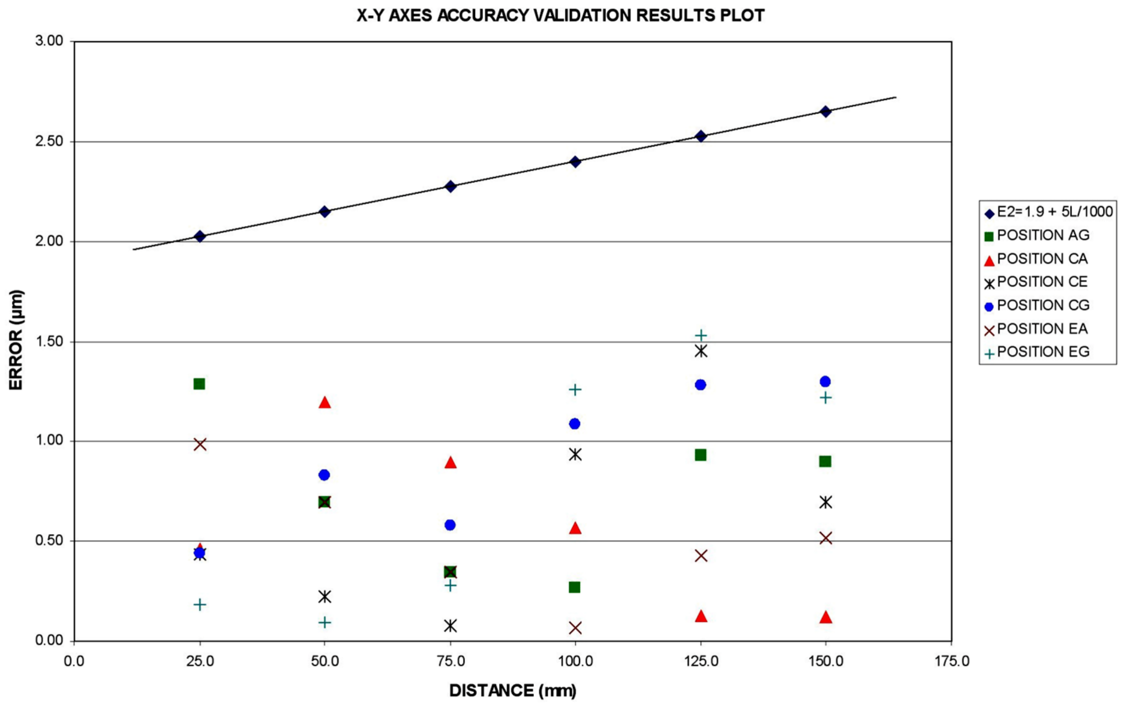


Figure 26. Calibration Error Chart Example

8.5 Cleaning

To the degree possible, the system should be kept in a clean environment, away from dirt, dust, oil, and debris which could affect system performance or degrade the system's mechanical and electronic parts. If a clean environment is not available, the machine should be kept as clean and protected as is possible. In harsh environments, preventive maintenance and factory service should be scheduled more frequently to keep the system in top working order.

WARNING

Never pour fluid on the system when cleaning. Do not over-wet cleaning cloth. Excessive moisture can seep into mechanical or electrical parts, damage the equipment and possibly cause an electrical short circuit and physical injury. As a precaution, unplug the system before cleaning. Always unplug the system before using any flammable cleaning fluid.

8.5.1 Cleaning External Surfaces

Wipe down the system with a clean, lint-free cloth moistened (not wet) with plain water, ammonia-free glass cleaner, or isopropyl alcohol. Never wipe down with acetone or other harsh solvents, which can damage painted or plastic surfaces.

8.5.2 Cleaning Optics

Caution

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.

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.
  - 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 AVR systems.

Spare Parts

Description	Part Number
AVR400 stage glass	9747-1

Accessories

Description	Part Number
NIST traceable combination field of view and magnification checker calibration standard	9123-1
150mm line standard	1434-1
200mm line standard	8736-1
Workstation	9986

Fixturing

Modular and easy to implement fixture solutions are available to improve the throughput, reproducibility, and accuracy of the inspection process. Contact on your SKE Sales Representative or SKE Technical Services department for more information.

9. Glossary

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

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

datum

In geometric dimensioning and tolerancing (GD&T), datum features are theoretically exact points, axes, lines, or planes. They serve as anchors for the entire part, allowing precise measurement and control.

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.

lens

A transparent optical component consisting of one or more pieces of optical glass with surfaces so curved that they serve to converge or diverge the transmit-ted rays from an object, thus forming a real or virtual image of that object.

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 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 AVR 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.

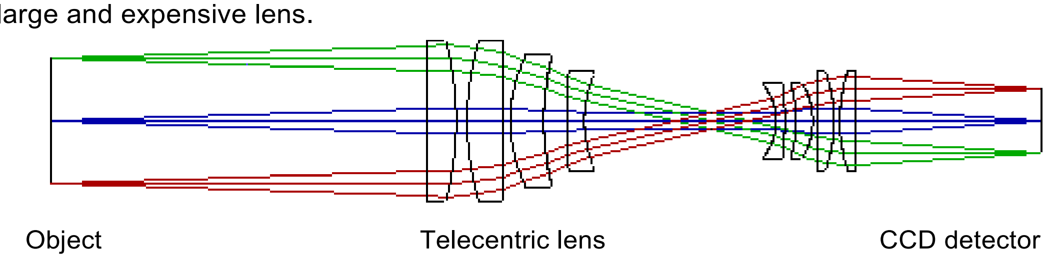
small form factor (system) PC

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

T

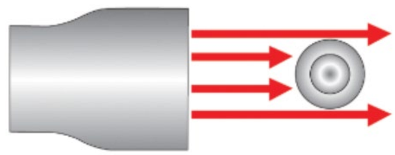
telecentric

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.

X

X-axis

The left to right movement of the stage.

Y

Y-axis

The front to back movement of the stage.

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.

Z-axis

The up and down movement of the system.