KEYENCE

NEW Microscope
General Catalog for Lenses and Stands

THE PEAK OF MAGNIFIED OBSERVATION

MICROSCOPE LENS

LINEUP CATALOG

KEYENCE Optical lenses continue to evolve
To take you beyond high resolution to enhanced ease of operation

Since selling our first laser photoelectric switch, KEYENCE has launched numerous products equipped with laser optic technology.
Laser displacement sensors, machine vision, 3-Axis control laser markers, laser microscopes, and digital microscopes. All of these products are equipped with optical lenses. We continually ask ourselves:
What can we do to deliver the best observation image?
What is required to achieve the highest level of operability?
KEYENCE's optical design technology is the result of our many years of experience.

All of this technology is poured into our optical microscope lenses.

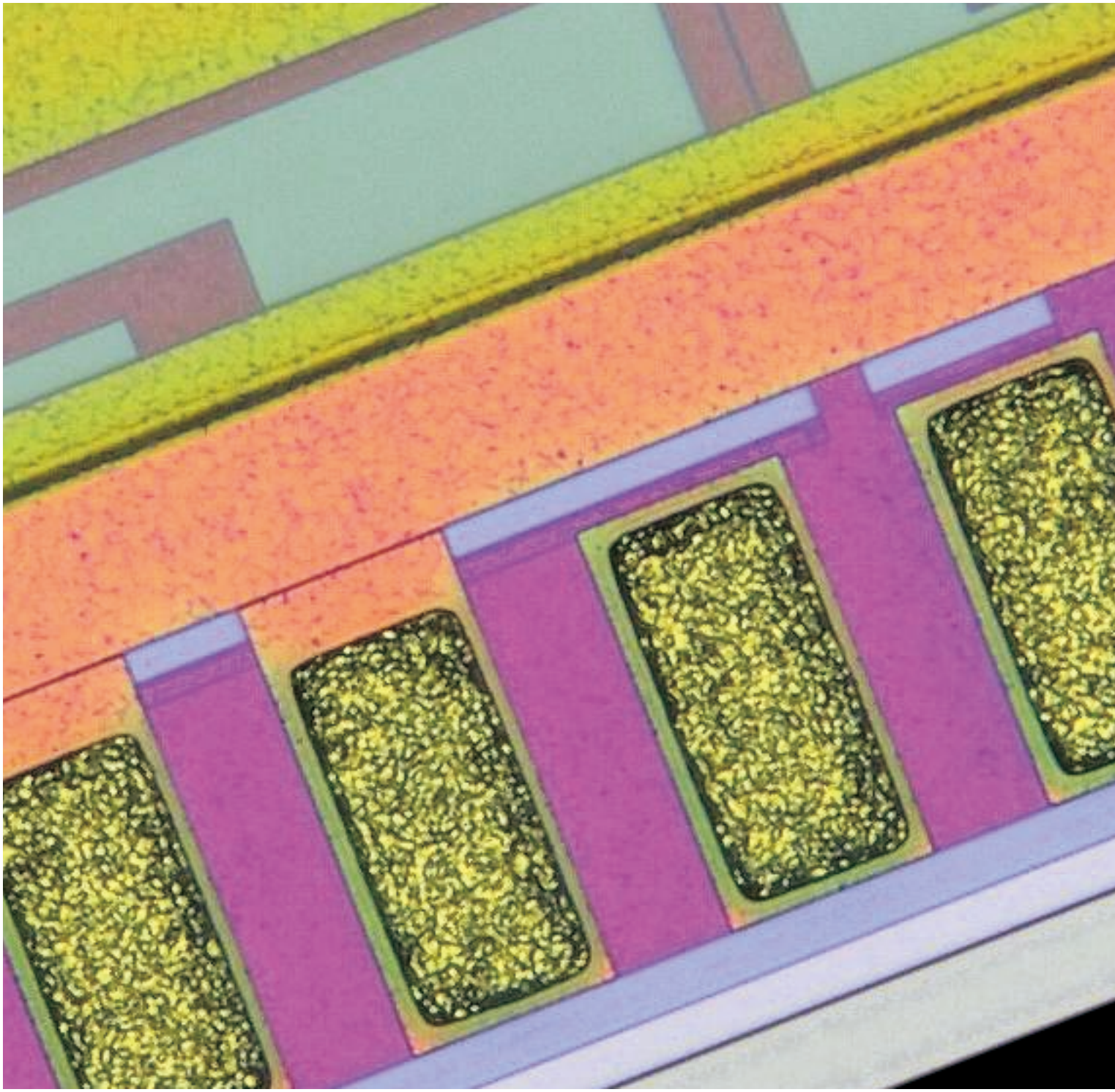
THE HIGHEST LEVEL OF LENS DEVELOPMENT

The resolution of the observed image in a microscope depends on the optical lens properties. Mindful of their critical role, KEYENCE has worked to develop lenses that meet the highest standard of perfection. The RZ-LENS is the result of our commitment and boasts the highest level of resolution in the industry.

Fixed lenses

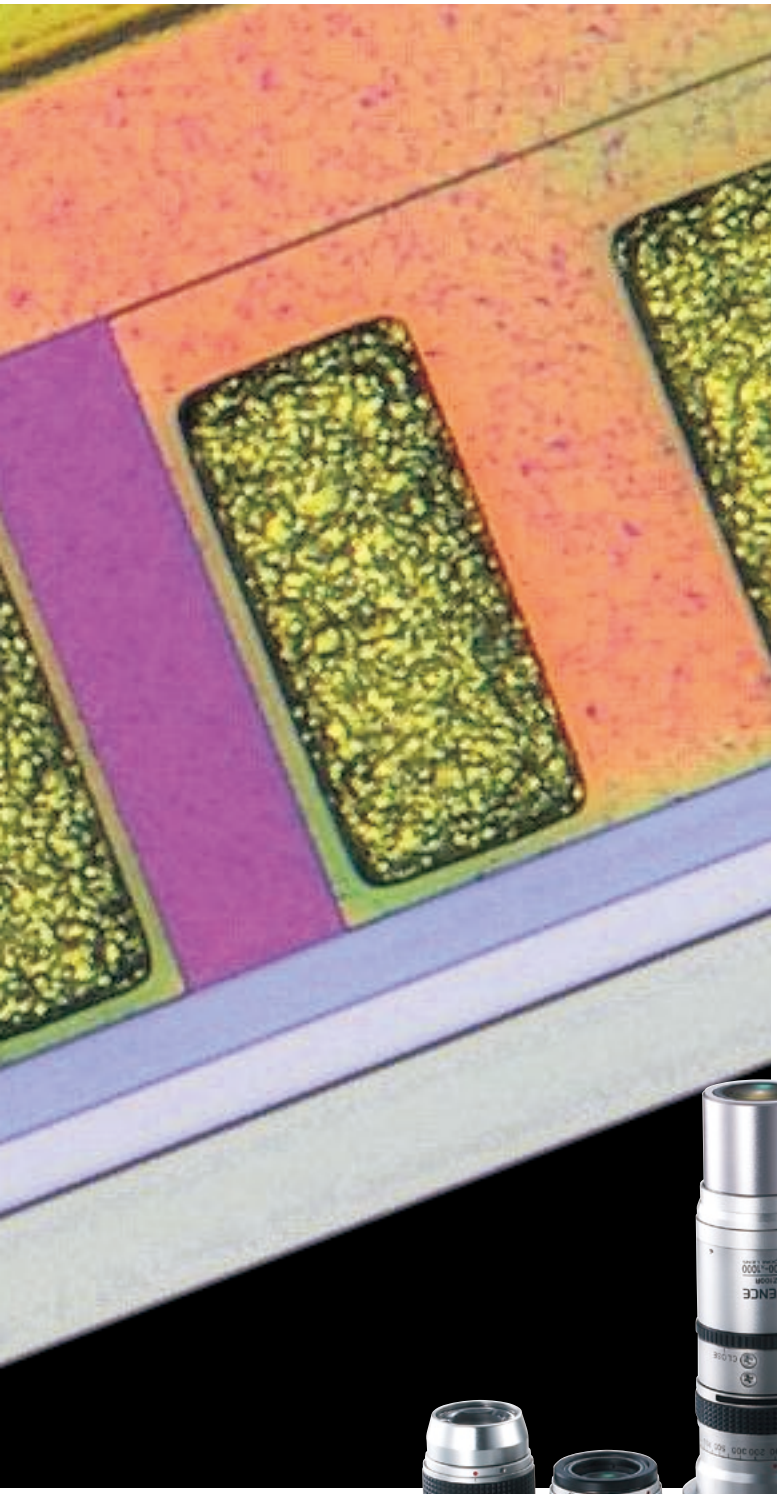
Zoom lenses

High resolution
RZ lenses



Bump (500x)

RZLENS



Challenging the limits of resolution.

When designing a lens, error dispersing lenses such as low-dispersion lenses, high-dispersion lenses, and fluorite lenses are essential to correcting chromatic aberration and other problems. The KEYENCE RZ lens uses a fluorite lens and multiple extra low-dispersion lenses (called ED lenses) to eliminate differences in focal length over a broad wavelength band. This translates into a lens with extremely low chromatic aberration that delivers stable optical performance. By using advanced optical theory and special optical materials, the RZ lens delivers a high resolution with up to 0.82 numerical aperture with 4.4 mm 0.17" of working distance.

Highest resolution in the industry

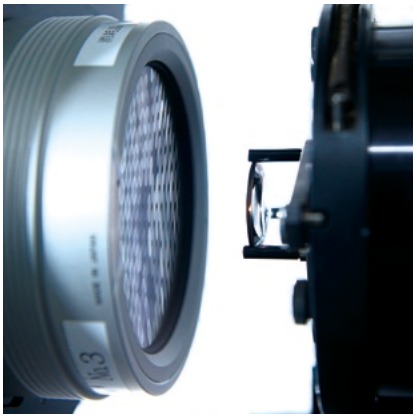
RZ LENS SERIES


EDGE
500
1000
2000
3000
KEYENCE
VH-Z500R
RZ
REAL
x500-x5000
ZOOM LENS

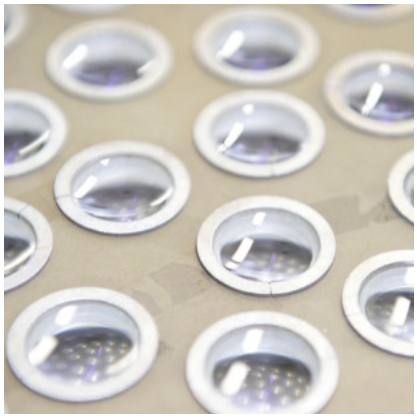
RZ LENS

Sophisticated polishing and assembly technology enables high-resolution observation

The RZ Lens Series boasts a maximum optical magnification of 5000 times. This level of performance demands the most exacting levels of machining and assembly technology. Every process from lens polishing and coating to the machining of parts like the lens tube and cam, as well as the assembly and quality inspection, are performed as an integrated process. Strict quality checks in each process ensure exceptional performance and quality.
For example, look at the objective glass lens, considered the heart of the lens. It is polished using an ultra-fine polishing process precise enough to keep the margin of error in the height of an area the size of the Alamodome to the thickness of a single sheet of copy paper. Skilled technicians using advanced assembly techniques assemble this precision-polished lens and precision-finished lens tube. This high level of optical technology supports the inherent ability digital microscopes have for revealing every detail.



Inspecting surface roughness with an interferometer



Surface coating

Hand-assembled lens

Ergonomically superior operability

Look at the VH-Z20R for example.
While a larger diameter would have been more advantageous in terms of optical characteristics, the easier to handle ø38 mm ø1.50" diameter lens was chosen for ergonomic comfort, whether stand-mounted or hand-held. In addition, chromatic aberration was corrected by selecting the best suited lens materials from dozens of choices, in order to maintain high resolution and deep depth of field. It takes sophisticated optical techniques to maintain brightness within a limited lens diameter. KEYENCE overcame the difficulties associated with machining and assembling zoom mechanisms by developing the ultra small ø38 mm ø1.50" zoom lens.

Coupling sensor technology with optical technique
Automatic Lens/Zoom Recognition, DOUBLE'R

KEYENCE coupled its years of experience in sensor technology with the optical technology of digital microscopes. Changes in lens power are sensed and signaled to the controller. When the controller receives this signal, it automatically updates internal calibration data and changes the power notation and scale display.

RZLENS

RZLENS

Quick-connect lenses

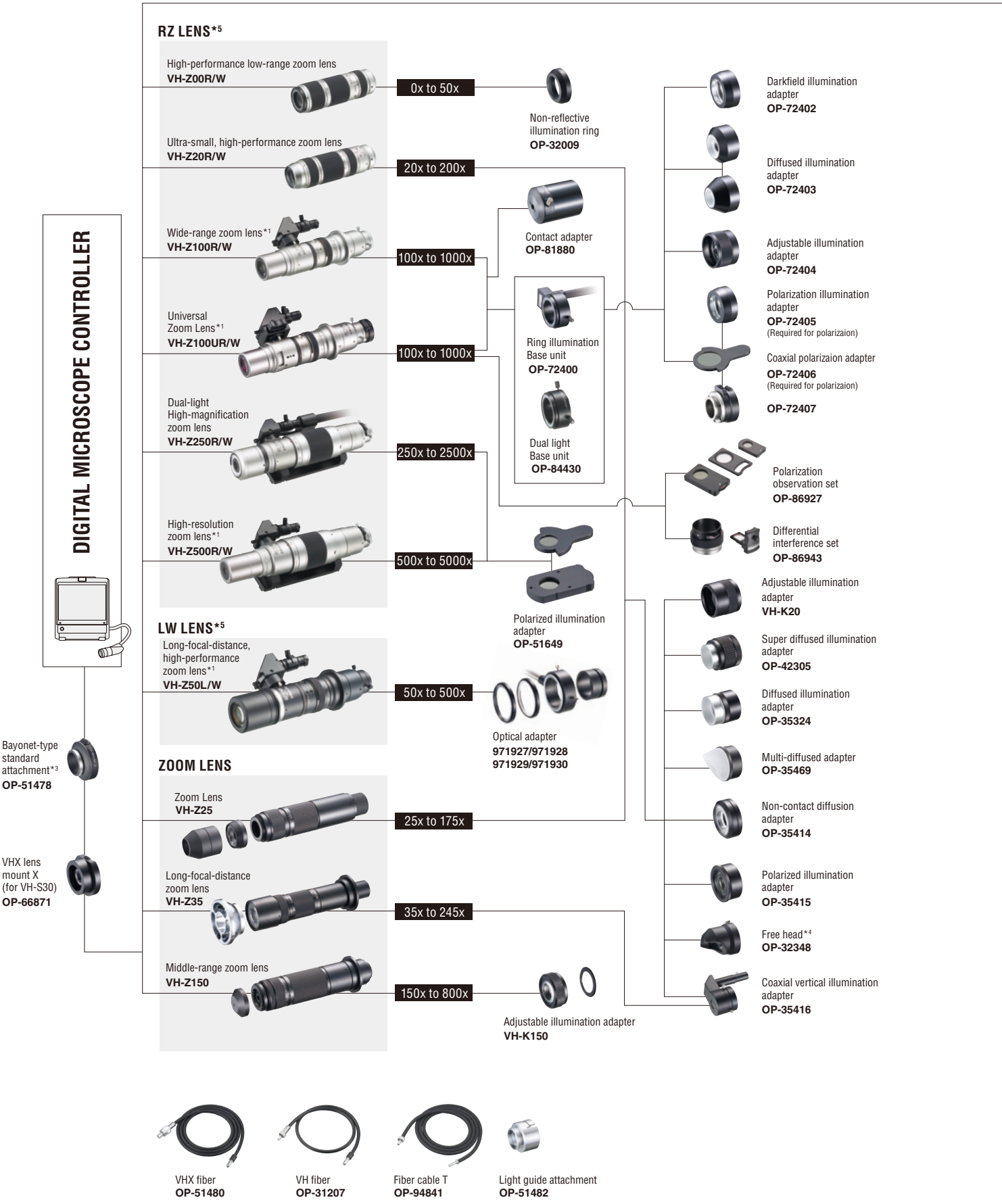
KEYENCE microscope optic lenses use an original Bayonet mount for quick-connect and disconnect from the camera. The lens can be removed and attached by twisting the tabs. This makes lens replacement easier than with threaded mounts. The design also supports C-mount lenses.

Dual light system

Look at the VH-Z250R for example.
It is the industry's first lens to incorporate both coaxial vertical illumination and ring illumination, a feature made possible with KEYENCE's original optical technology. Because there is no need to replace the lens or illumination, anyone can easily and quickly switch between lighting methods.

Optical 10x zoom lens

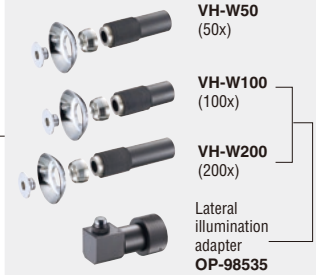
The RZ lenses cover a wide zoom range from 0.1x to 5000x, each with an optical 10x zoom range. To achieve an optical 10x zoom, highly skilled assembly techniques are required to eliminate the tiniest amount of error in the zoom mechanism. The wide range design of the RZ lens allows seamless viewing of targets from macro-view to micro-view. It also maintains a fixed observation distance over the full zoom range, making it easy to work with. This all-around zoom lens is suitable for any application.


RZ LENS*5
High-performance low-range zoom lens
VH-Z00R/W
0x to 50x
Ultra-small, high-performance zoom lens
VH-Z20R/W
20x to 200x
Wide-range zoom lens*1
VH-Z100R/W
100x to 1000x
Universal
Zoom Lens*1
VH-Z100UR/W
100x to 1000x
Dual-light
High-magnification
zoom lens
VH-Z250R/W
250x to 2500x
High-resolution
zoom lens*1
VH-Z500R/W
500x to 5000x
LW LENS*5
Long-focal-distance,
high-performance
zoom lens*1
VH-Z50L/W
50x to 500x
ZOOM LENS
Zoom Lens
VH-Z25
25x to 175x
Long-focal-distance
zoom lens
VH-Z35
35x to 245x
Middle-range zoom lens
VH-Z150
150x to 800x
DIGITAL MICROSCOPE CONTROLLER
Bayonet-type
standard
attachment*3
OP-51478
VHX lens
mount X
(for VH-S30)
OP-66871
Non-reflective
illumination ring
OP-32009
Contact adapter
OP-81880
Ring illumination
Base unit
OP-72400
Dual light
Base unit
OP-84430
Polarized illumination
adapter
OP-51649
Optical adapter
971927/971928
971929/971930
Adjustable illumination adapter
VH-K150
Darkfield illumination
adapter
OP-72402
Diffused illumination
adapter
OP-72403
Adjustable illumination
adapter
OP-72404
Polarization illumination
adapter
OP-72405
(Required for polarizaion)
Coaxial polarizaion adapter
OP-72406
(Required for polarizaion)
OP-72407
Polarization
observation set
OP-86927
Differential
interference set
OP-86943
Adjustable illumination
adapter
VH-K20
Super diffused illumination
adapter
OP-42305
Diffused illumination
adapter
OP-35324
Multi-diffused adapter
OP-35469
Non-contact diffusion
adapter
OP-35414
Polarized illumination
adapter
OP-35415
Free head*4
OP-32348
Coaxial vertical illumination
adapter
OP-35416
VHX fiber
OP-51480
VH fiber
OP-31207
Fiber cable T
OP-94841
Light guide attachment
OP-51482

FIXED-MAGNIFICATION LENS

VH-20 (20x)
VH-50 (50x)
VH-100 (100x)
VH-200 (200x)
VH-500 (500x)
VH-1000 (1000x)

LONG-FOCAL-DISTANCE LENS



VH-W50 (50x)
VH-W100 (100x)
VH-W200 (200x)
Lateral illumination adapter **OP-98535**

HYPER-VIEW LENS

VH-V100 (100x)
VH-V200 (200x)

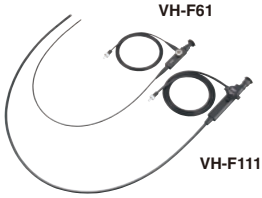
VERTICAL-ILLUMINATION LENS

VH-C501 (500x)
VH-C1001 (1000x)

Bayonet-type C-mount attachment **OP-51479**

FIBERSCOPE*2

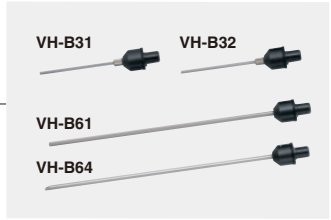
VH-F



VH-F61
VH-F111

BORESCOPE LENS

VH-B



VH-B31
VH-B32
VH-B61
VH-B64

BORESCOPE LENS*6

OP-32681

OP-32666
OP-32665
OP-32664
OP-32663
OP-32662

OPTION

Free-angle observation system **VH-S30**

Free-angle observation system (Z-axis automatic) **VHX-S50**

X-Y measurement system **VH-M100**

High-precision VH mounting stand (with X-Y stage and transmitted illumination) **VH-S5**

VH lens mounting stand **OP-25539**

XY stage **OP-22124**

*1. The optional light guide dedicated to the VHX Series is required. OP-51480: VH-Z100R/Z100UR/Z500R/Z50L
*2. The optional light guide attachment (OP-51482) dedicated to the VHX Series is required.
*3. For the VH-Z100R/Z250R/Z500R/Z50L, OP-51647 is required.
*4. OP-32348 is the special adapter for the VH-Z25.
*5. DOUBLE'R compliant lenses VH-Z00W/Z20W/Z100W/Z100UW/Z250W/ Z500W/Z50W are fitted with Automatic Lens/Zoom Recognition units, respectively.
*6. The optional bore fiber cable (OP-33242) and the light guide attachment (OP-51482)dedicated to the VHX Series are required.

CONTENTS

HIGH-PERFORMANCE LOW-RANGE ZOOM LENS

0 ▸ 50

VH-Z00R/Z00W NEW

- Capable of capturing the entire target in the field of view with the infinite observation method
- Ultra-small zoom lens with 95 mm 3.74" observation distance for excellent workability
- 0x to 50x optical 10x zoom

Ring Illumination

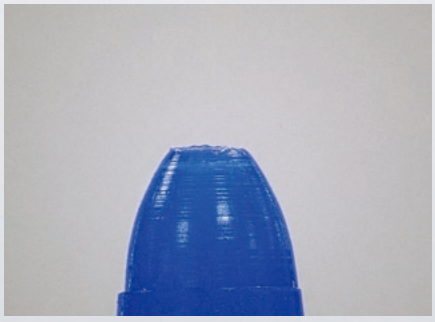
VH-Z00R

VH-Z00W
Fitted with automatic lens/ zoom recognition unit

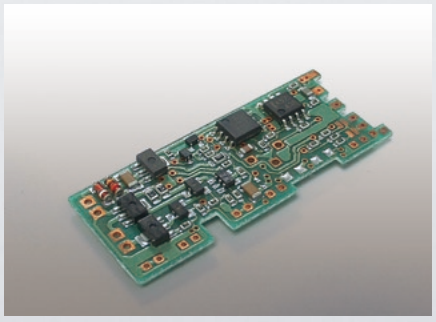
View targets from macro-view to micro-view

Targets can be viewed from a macro-level to a micro-level over the entire 0-50x zoom range. This high-performance macro lens excels in workability with click-style magnification, an aperture mechanism, and an observation distance of 95 mm 3.74" or more.

Bearing (50x)



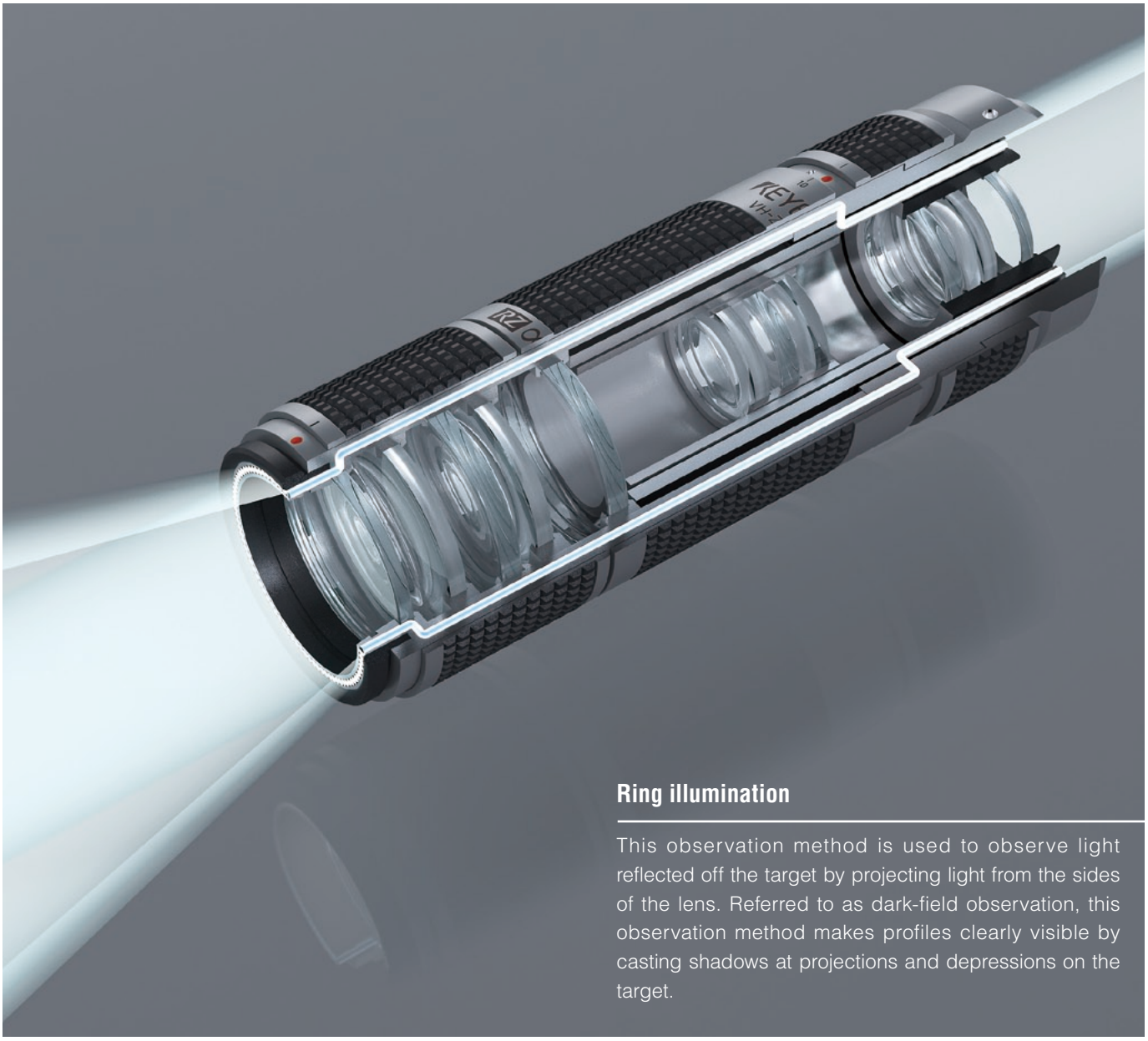
Plastic nozzle tip (50x)



PC board (5x)

Macro Observation (infinite observation)

The VH-Z00R/W supports macro observation. This refers to the act of widening the field of view by moving the lens away from the target (increasing the observation distance), and focusing on the entire image displayed in the view. Widening the observation distance allows observation at an infinite depth of field.



Ring illumination

This observation method is used to observe light reflected off the target by projecting light from the sides of the lens. Referred to as dark-field observation, this observation method makes profiles clearly visible by casting shadows at projections and depressions on the target.

OPTION

Non-reflective ring OP-32009

This ring cuts the amount of light that directly hits the target to allow observation with less reflection.

LENS PERFORMANCE

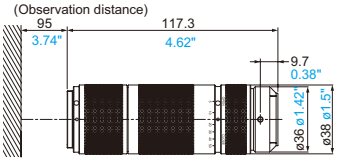
Magnification[1]		0.1 x	0.5 x	1 x	5 x	10 x	30 x	50 x
Monitoring range (mm inch)	Horizontal	3200 126"	640 25.2"	320 12.6"	61 2.40"	30.5 1.20"	10.2 0.40"	6.1 0.24"
	Vertical	2400 94.49"	480 18.9"	240 9.45"	45.5 1.79"	22.8 0.80"	7.6 0.30"	4.6 0.18"
	Diagonal	4000 157.5"	800 31.5"	400 15.75"	76.2 3"	38.1 1.5"	12.7 0.5"	7.6 0.30"
Observation distance (mm inch)		Approx. 7700 303.1"	Approx. 1500 59.08"	Approx. 720 28.35"	95 3.74"			

1. Magnification on a 15-inch monitor.

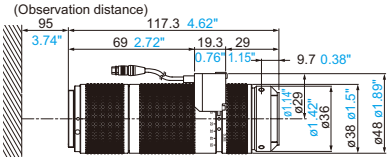
DIMENSIONS

Unit: mm inch

VH-Z00R



VH-Z00W



ULTRA-SMALL, HIGH-PERFORMANCE ZOOM LENS

20 ▸ 200

VH-Z20R/Z20W NEW

- The ultimate level in depth of field, approximately twice that of conventional lenses
- Suitable for hand-held observation, offers highly flexible observation
- Uniform 25.5 mm observation distance over the full 20-200x zoom range

Coaxial vertical illumination | Ring illumination | Diffused illumination

Variable illumination | Polarized illumination

VH-Z20R

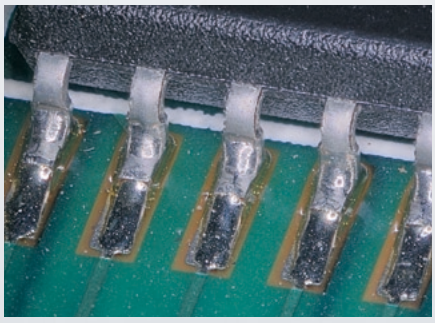
VH-Z20W

Fitted with automatic lens/ zoom recognition unit.

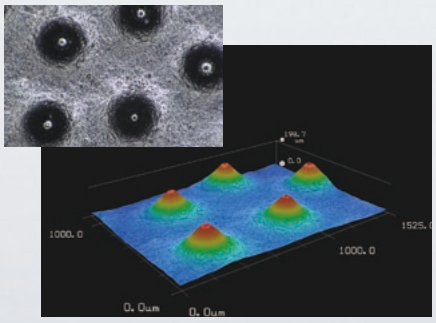
High resolution, ultra-small lens

The VH-Z20R/W offers high-resolution observation at the most commonly used magnifications from 20x to 200x. It also has an enhanced depth of field which is a standard feature of our existing lenses. It offers good telecentricity for exceptionally clear, comprehensive images, even when constructing 3D images or using depth composition.

Connector (50x)



PC board (50x)



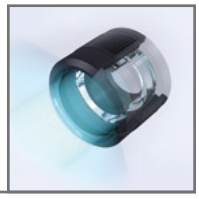
File in 3D (50x)

Depth of Field

When displaying a target through a lens, a range exists where the target appears in focus even if the distance between it and the lens changes slightly. In other words, there is an acceptable range of the focal position of the lens in which the target appears in highest clarity, known as the depth of field. In this range, the target remains in focus even if the lens is moved closer or farther away. A lens with a wide acceptable range is referred to as a lens with a deep depth of field. Because the VH-Z20R is designed with a deep depth of field, it allows you to easily observe targets with height differences and to observe the entire target accurately and quickly.

OPTIONS

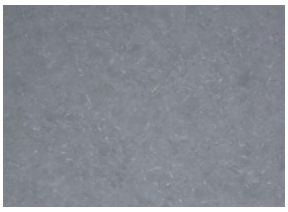
Variable illumination adapter



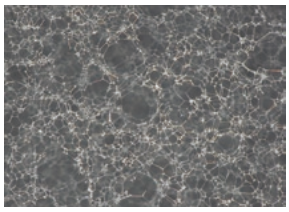
The variable illumination adapter is attached to the end of the lens and has a ring that, when turned, changes the incident angle of light from vertical to flanking illumination (approx. 10 degrees). This allows easier observation of minute height differences or scratches.

VH-K20

Sponge (50x)

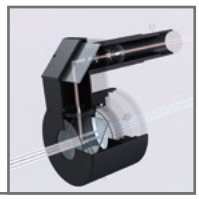


Standard illumination



Variable illumination

Coaxial vertical adapter



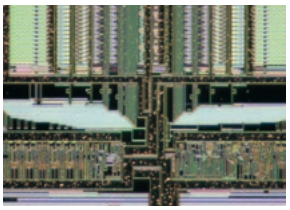
This adapter uses a half mirror to align the axis of light illuminated on the target with the optical axis of the lens. This increases the amount of regular reflection and is used for bright-field observation.

OP-35416

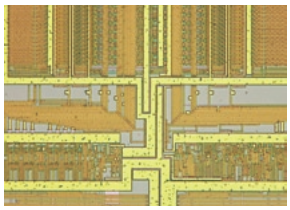
OP-94841

OP-51482

IC circuit (1000x)



Without adapter (dark-field)



With adapter (bright-field)

Diffuse illumination adapter

The diffuse illumination adapter is attached to the end of the lens to provide an even amount of light over the target. It uses a frosted optical filter to diffuse the domed light source.

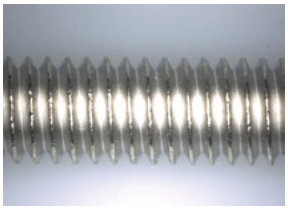
OP-42305

OP-35414

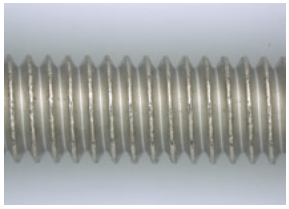
OP-35469

OP-35324

Screw threads (30x)



Standard illumination



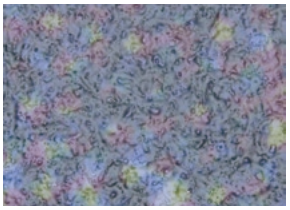
Diffuse illumination

Polarized illumination adapter

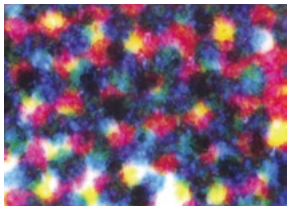
Passing polarized illumination through a polarized filter turned 90 degrees cuts only regular reflected light.

OP-35415

Coated surface (200x)



Standard illumination



Polarized illumination

LENS PERFORMANCE

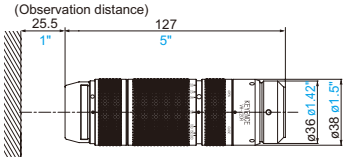
Magnification [1]		20x	30x	50x	100x	150x	200x
Monitoring range (mm inch)	Horizontal	15.24 0.60"	10.16 0.40"	6.10 0.24"	3.05 0.12"	2.03 0.08"	1.52 0.06"
	Vertical	11.40 0.45"	7.60 0.30"	4.56 0.18"	2.28 0.09"	1.52 0.06"	1.14 0.04"
	Diagonal	19.05 0.75"	12.70 0.50"	7.62 0.30"	3.81 0.15"	2.54 0.10"	1.91 0.08"
Depth of field (mm inch) [2]		34 1.34"	15.5 0.61"	6.0 0.24"	1.6 0.06"	0.74 0.03"	0.44 0.02"
Observation distance (mm inch)		25.5 1"					

1. Magnification on a 15-inch monitor.
2. The value when the lens is set with priority to depth of field.
The depth of field changes depending on the setting for the iris diaphragm ring.

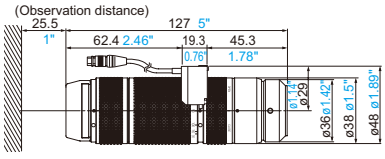
DIMENSIONS

Unit: mm inch

VH-Z20R
With non-contact light ring



VH-Z20W
With non-contact light ring



WIDE-RANGE ZOOM LENS

100 ▸ 1000

VH-Z100R/Z100W NEW

- The ultimate level in depth of field, approximately twice that of conventional lenses
- Supports the Dual Light mechanism (quick changeover between bright-field and dark-field)
- Uniform 25 mm 0.98" observation distance over the full 100-1000x zoom range

Coaxial vertical illumination | Ring illumination | Diffused illumination

Variable illumination | Polarized illumination

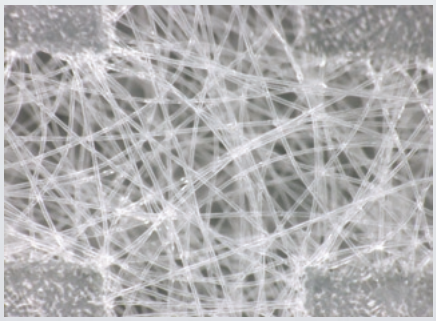
VH-Z100R

VH-Z100W

Fitted with automatic lens/ zoom recognition unit.

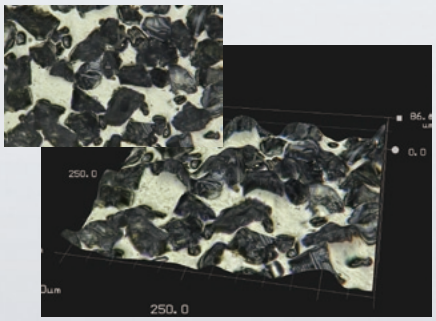
Fitted with automatic lens/zoom recognition unit

This innovative lens offers a wide zoom range from 100-1000x, and establishes a new standard in lenses by meeting the contradictory needs of high resolution and extremely deep depth of field.



Non-woven cloth (200x)

Metal structure (400x)



Grindstone in 3D (500x)

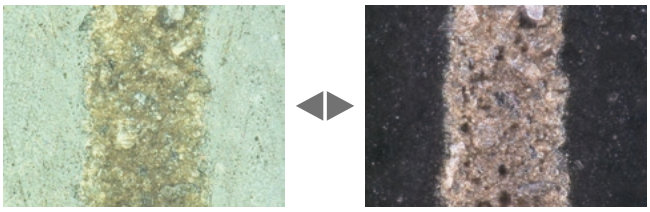
Optical Aberration

Light entering the lens converges into a single point at the focal position of the lens. However, because light has different wavelengths, it does not converge into an actual point at the focal position. Rather, a certain amount of error known as aberration exists. Aberration causes the image to form at a different point which can impart coloration to the image or blur the color of the image. The image may develop a tail that extends from the light axis or it may appear distorted. As such, the less aberration a lens has, the better it is considered to be. Aberration is commonly more pronounced at the periphery than at the center. The VH-Z100R is designed using a combination of multiple lenses made of materials with opposing properties that cancel the aberration of each individual lens and reduce degradation of the picture quality.

Dual Light Unit OP-84430

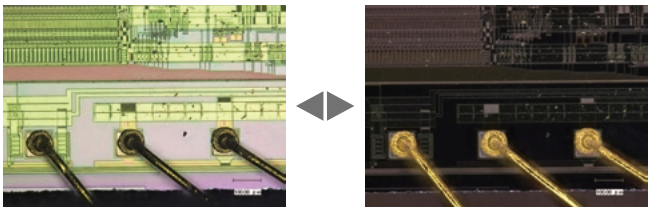
This light unit incorporates two lighting mechanisms: coaxial vertical illumination (bright-field observation) and ring lighting (dark-field observation). Users can switch between the two with a single operation. The optical adapter on the end can be replaced for observation using other lighting techniques.

Laser engraving (1000x)



Bright-field | Dark-field

IC (500x)



Bright-field | Dark-field

OPTIONS

Ring illumination adapter

OP-72402

Variable illumination adapter

OP-72404

Diffuse illumination adapter

OP-72403

Contact adapter

OP-81880

Polarized illumination adapter

OP-72405
OP-72406
OP-72407

Fiber cables

OP-31207
OP-51480

LENS PERFORMANCE

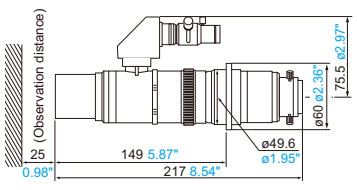
Magnification [1]		100x	200x	300x	500x	700x	1000x
Monitoring range (mm inch)	Horizontal	3.05 0.12"	1.53 0.06"	1.02 0.04"	0.61 0.02"	0.44 0.02"	0.30 0.01"
	Vertical	2.28 0.09"	1.14 0.04"	0.76 0.03"	0.46 0.02"	0.33 0.01"	0.23 0.01"
	Diagonal	3.81 0.15"	1.90 0.07"	1.27 0.05"	0.76 0.03"	0.54 0.02"	0.38 0.01"
Observation distance (mm inch)		25 (20 [2]) 0.98" (0.79 [2])					

1. Magnification on a 15-inch monitor.
2. The Dual Light Base Unit (OP-84430) and the Adjustable Illumination (OP-72402) are attached.

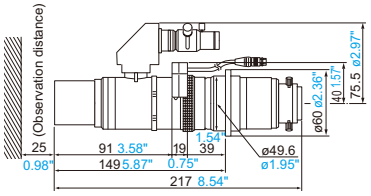
DIMENSIONS

Unit: mm inch

VH-Z100R



VH-Z100W



100 ▸ 1000

VH-Z100UR/Z100UW NEW

- Performs bright-field, dark-field, polarization, and differential interference observation
- The ultimate level in depth of field, approximately twice that of conventional lenses
- Uniform 25 mm 0.98" observation distance over the full 100-1000x zoom range

Coaxial vertical illumination | Ring illumination | Diffused illumination

Variable illumination | Polarized illumination | Differential interference

VH-Z100UR

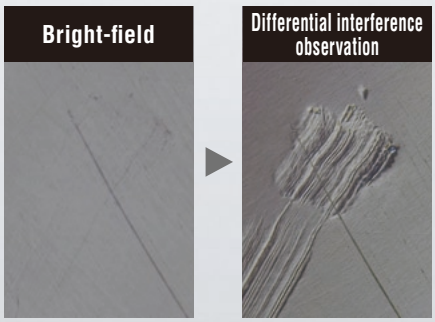
VH-Z100UW

Fitted with automatic lens/ zoom recognition unit.

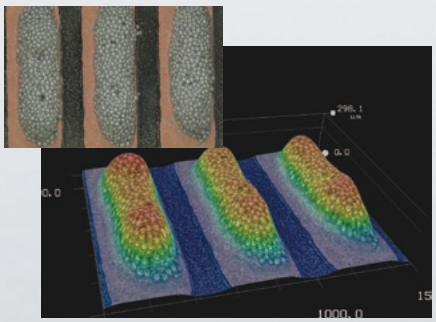
Supports various observation techniques

The VH-Z100UR inherits the optical design of the VH-Z100R, which offers a 25 mm 0.98" observation distance over the 100-1000x zoom range. It supports high-resolution observation in bright-field and dark-field over a wide zoom range, and can be used in various applications including polarization and differential interference observation.

Color filter (500x)



Dents in metal (300x)



Soldering in 3D (200x)

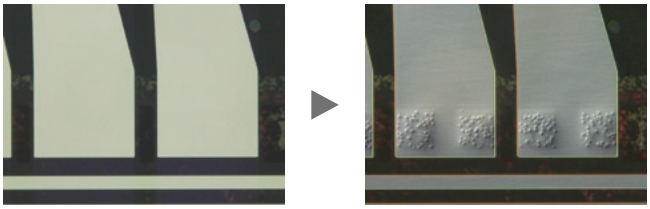
Differential Interference

Using this method, a high-contrast DIC prism inserted into the lens separates the light into two paths. Both paths reflect off of projections and depressions on the target at different lengths, which when overlapped highlight the differences with contrast. This method visualizes minute projections, depressions, and transparent targets with contrast that is otherwise invisible with a normal lens.

Reveals projections and depressions invisible with bright-field observation

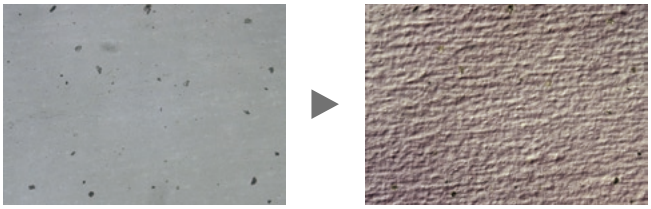
The high-contrast DIC prism separates light into two paths that are reflected and made to interfere, making minute projections and depressions on the target clearly visible. This technique allows clear observation of scratches in metal or glass, and waviness or unevenness in film.

ACF surface



Bright-field (500x) | Differential interference (500x)

Magnetic tape

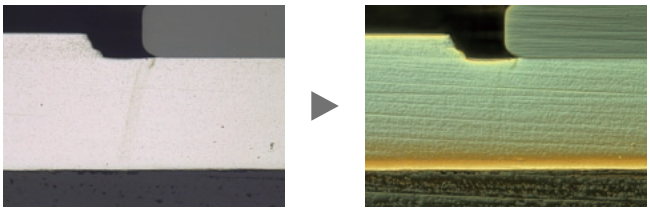


Bright-field (200x) | Differential interference (200x)

Using color to discern height differences

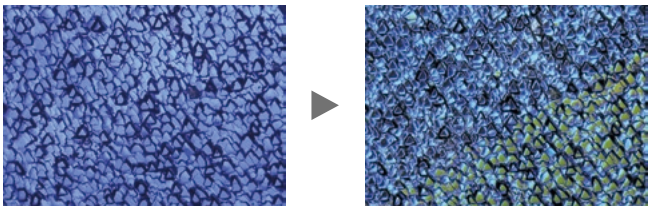
This technique combines an analyzer, polarizer, and λplate to cause changes in the phase of reflected light polarized onto the target. The changes in height appear as color, visually highlighting minute projections and depressions in the target.

Cross-section of metal



Bright-field (300x) | Differential interference (300x)

Solar cell



Bright-field (150x) | Differential interference (150x)

OPTIONS

SCP filter set

OP-86927

DIC prism set

OP-86943

Fiber cables

OP-31207
OP-51480

Variable illumination adapter

OP-72404

Ring illumination adapter

OP-72402

Diffuse illumination adapter

OP-72403

Contact adapter

OP-81880

LENS PERFORMANCE

Magnification [1]		100x	200x	300x	500x	700x	1000x
Monitoring range (mm inch)	Horizontal	3.05 0.12"	1.53 0.06"	1.02 0.04"	0.61 0.02"	0.44 0.02"	0.30 0.01"
	Vertical	2.28 0.09"	1.14 0.04"	0.76 0.03"	0.46 0.02"	0.33 0.01"	0.23 0.01"
	Diagonal	3.81 0.15"	1.90 0.07"	1.27 0.05"	0.76 0.03"	0.54 0.02"	0.38 0.01"
Observation distance (mm inch)		25 (20[2]) 0.98" (0.79[2])					

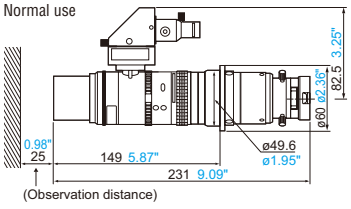
1. Magnification on a 15-inch monitor.
2. The Dual Light Base Unit (OP-84430) and the Adjustable Illumination (OP-72402) are attached.

DIMENSIONS

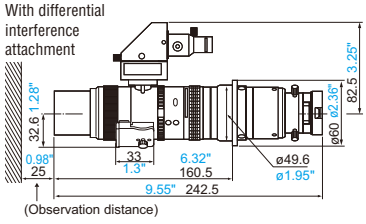
Unit: mm inch

VH-Z100UR

Normal use

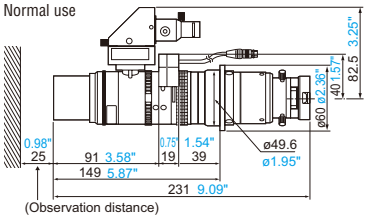


With differential interference attachment

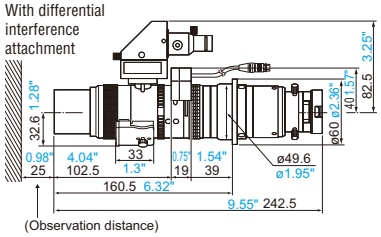


VH-Z100UW

Normal use



With differential interference attachment



DUAL LIGHT HIGH-MAGNIFICATION ZOOM LENS

250 ▸ 2500

VH-Z250R/Z250W NEW

- Equipped with the Dual Light mechanism (quick changeover between bright-field and dark-field)
- Capable of dark-field observation to a maximum 2500x
- Uniform 6.5 mm 0.26" observation distance over the full 250-2500x zoom range

Coaxial vertical illumination | Ring illumination | Polarized illumination

VH-Z250R

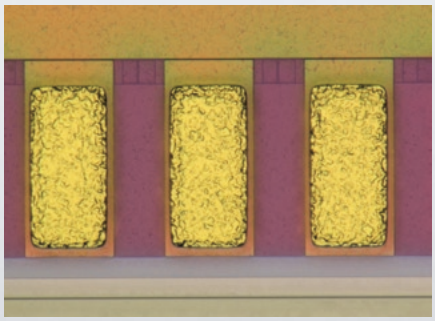
VH-Z250W

Fitted with automatic lens/ zoom recognition unit.

During observation, illumination for dark field and bright field can be easily switched

This lens incorporates dual illumination mechanisms: coaxial vertical illumination and ring illumination.

Cross-section of photo film (250x)

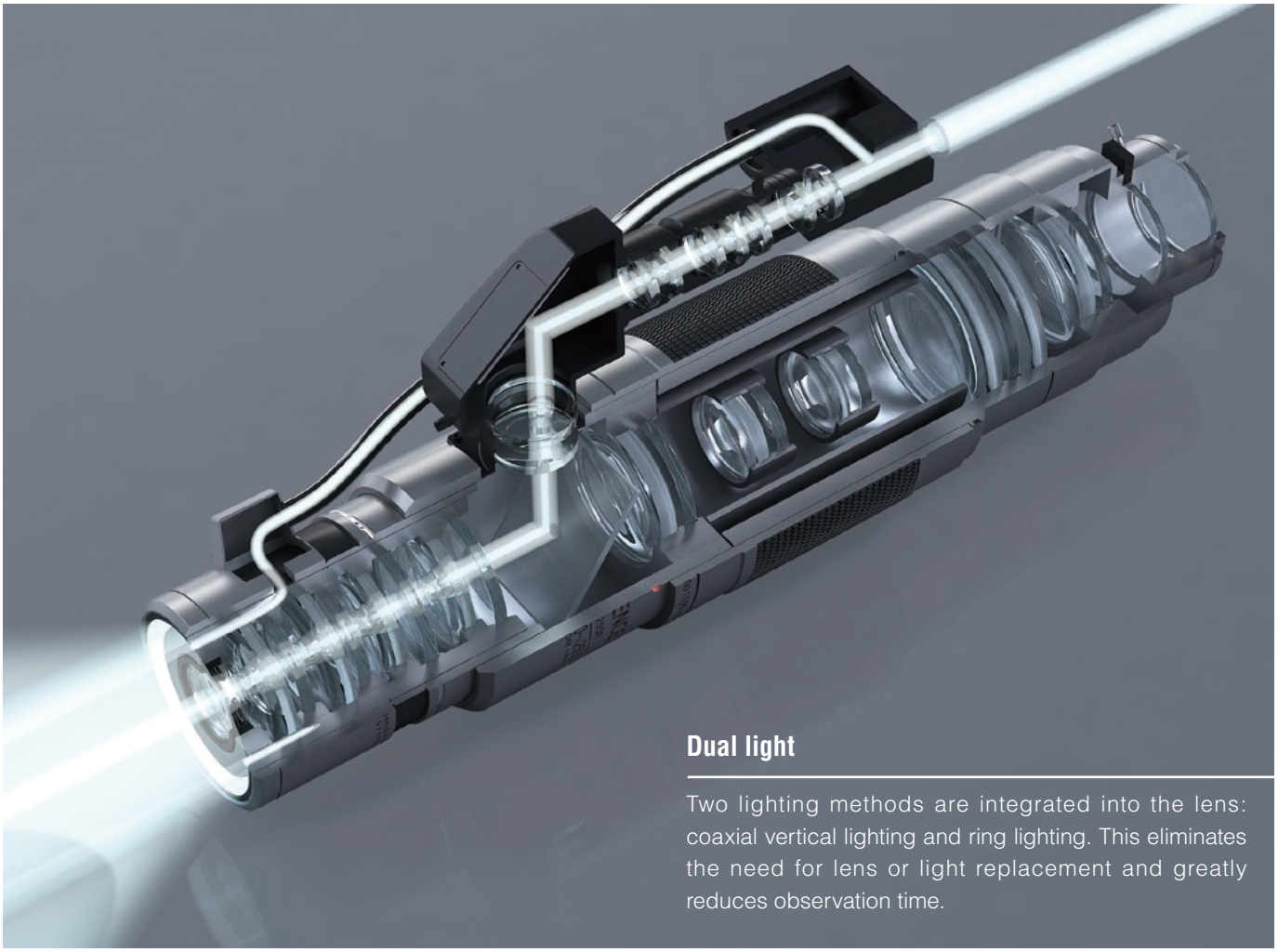


Bump (1000x)

Probe dent (2000x)

Dual Light

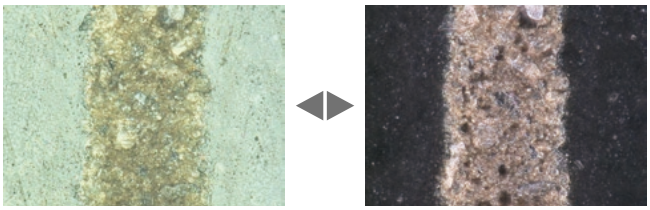
The dual light lens is a high magnification lens equipped with coaxial vertical illumination and standard-mounted ring illumination on the end. The 6.5 mm 0.26" observation distance enables dark-field observation, which is otherwise difficult at high magnification ranges due to the short observation distance to the target. The quick illumination changeover makes this particularly easy for anyone to use.



Dual light

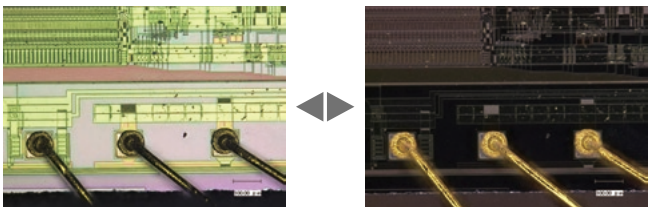
Two lighting methods are integrated into the lens: coaxial vertical lighting and ring lighting. This eliminates the need for lens or light replacement and greatly reduces observation time.

Laser engraving (1000x)



Bright-field　　Dark-field

IC (500x)



Bright-field　　Dark-field

OPTION

Polarized illumination adapter

OP-51649

LENS PERFORMANCE

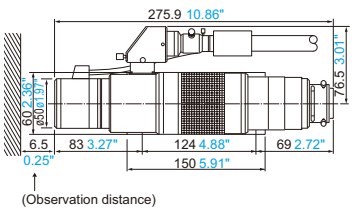
Magnification [1]		250x	300x	500x	1000x	1500x	2000x	2500x
Monitoring range (mm inch)	Horizontal	1.22 0.05"	1.02 0.04"	0.61 0.02"	0.31 0.01"	0.2 0.01"	0.15 0.005"	0.12 0.004"
	Vertical	0.92 0.04"	0.76 0.03"	0.46 0.02"	0.23 0.01"	0.15 0.005"	0.11 0.004"	0.09 0.003"
	Diagonal	1.52 0.06"	1.27 0.05"	0.76 0.03"	0.38 0.01"	0.25 0.009"	0.19 0.007"	0.15 0.005"
Observation distance (mm inch)		6.5 0.26"						

1. When displayed on a standard 15-inch monitor.

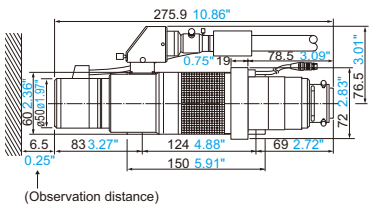
DIMENSIONS

Unit: mm inch

VH-Z250R



VH-Z250W



HIGH-RESOLUTION ZOOM LENS

500 ▸ 5000

VH-Z500R/Z500W NEW

- Highest resolution in its class, 0.82 numerical aperture
- Uniform 4.4 mm 0.17" observation distance over the full 500-5000x zoom range
- Accepts polarized illuminations

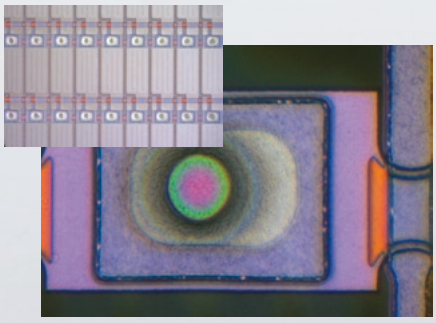
Coaxial vertical illumination | Polarized illumination

VH-Z500R

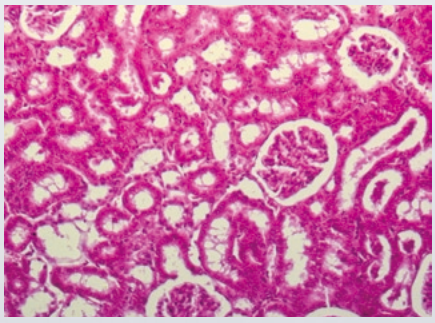
VH-Z500W
Fitted with automatic lens/ zoom recognition unit.

This zoom lens is the pinnacle of optical lenses

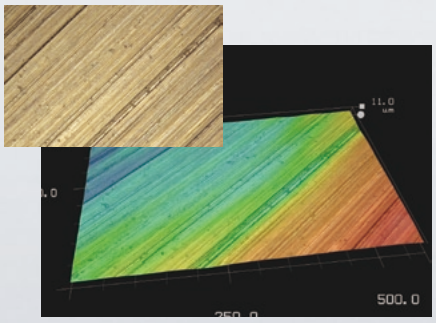
This zoom lens incorporates high-quality fluorite optics to provide the highest resolution in its class. The advanced 3D display function precisely reproduces images.



TFT (5000x)



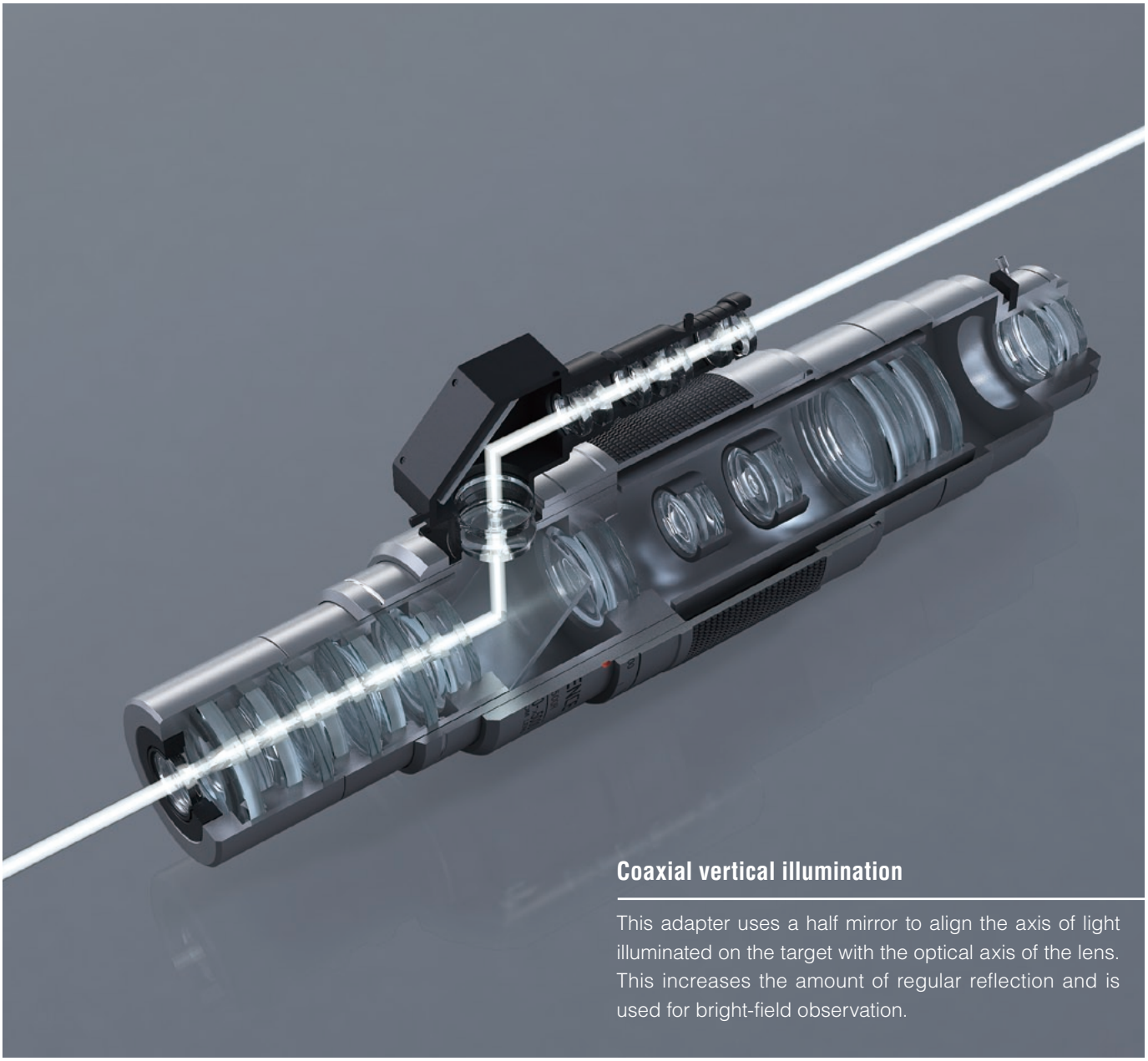
Cell (2000x)



Metal surface in 3D (500x)

Numerical Aperture (N.A.)

The numerical aperture for the VH-Z500R is 0.82. Numerical aperture is often abbreviated as N.A. Its value indicates the brightness and resolution of the optical system. Numerical aperture is defined by N.A. = N sinθ (N: refractive index of the medium around the target/ N is 1 in air), where θ is the effective diameter of the lens that receives incident light from the target on the optical axis. When the observation medium is air, the closer the N.A. is to 1, the higher the resolution and sharper the image will appear.



Coaxial vertical illumination

This adapter uses a half mirror to align the axis of light illuminated on the target with the optical axis of the lens. This increases the amount of regular reflection and is used for bright-field observation.

OPTIONS

Fiber cables

OP-31207
OP-51480

Polarized illumination adapter

OP-51649

LENS PERFORMANCE

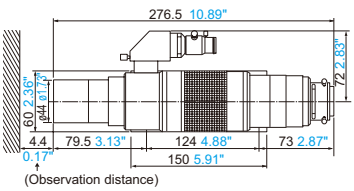
Magnification [1]		500x	1000x	2000x	3000x	5000x
Monitoring range (µm Mil)	Horizontal	610 24.02	305 12.01	152 5.98	102 4.02	61 2.4
	Vertical	457 17.99	229 9.02	114 4.49	76 2.99	46 1.81
	Diagonal	762 30	381 15	191 7.52	127 5	76 2.99
Observation distance (mm inch)		4.4 0.17"				

1. Magnification on a 15-inch monitor.

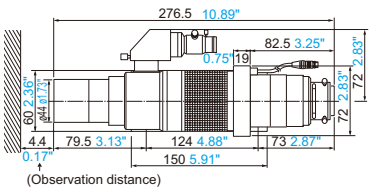
DIMENSIONS

Unit: mm inch

VH-Z500R



VH-Z500W



LONG-FOCAL-DISTANCE, HIGH-PERFORMANCE ZOOM LENS

50 ▸ 500

VH-Z50L/Z50W NEW

- 85 mm 3.35" observation distance at up to 500x zoom
- 50x to 500x optical 10x zoom lens
- Deep depth of field, approximately three times that of conventional lenses

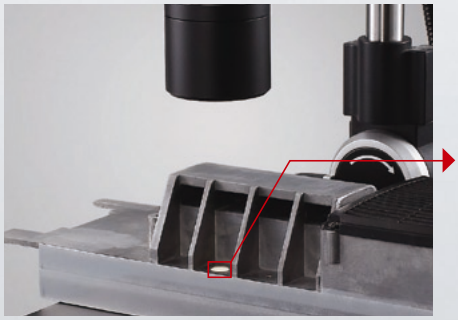
Coaxial vertical illumination | Ring illumination | Diffused illumination | Polarized illumination

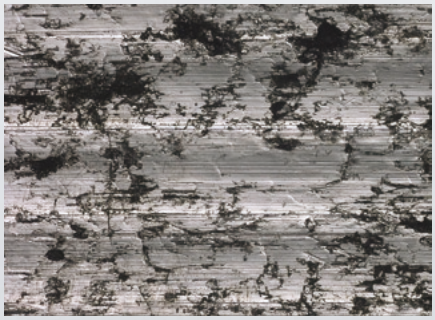
VH-Z50L

VH-Z50W
Fitted with automatic lens/ zoom recognition unit.

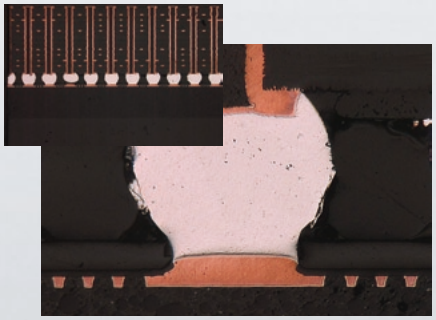
Long Range Lens with a 85 mm 3.35" Working Distance

This lens uses cutting-edge optical design and advanced illumination technology to maintain an 85 mm 3.35" observation distance even at the maximum 500x magnification. It can capture recesses in the target clearly and it offers ample working space for dramatically improved observation efficiency.





Metal surface (300x)

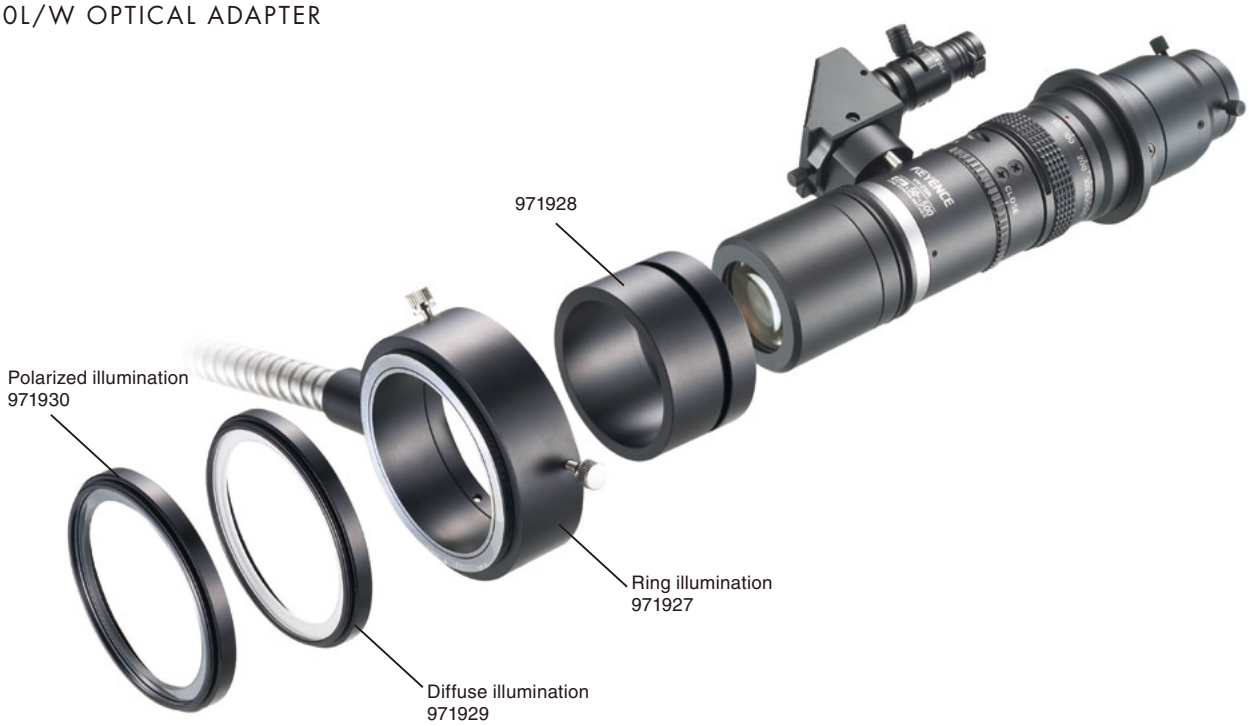


Cross-section of a BGA (500x)

Long Working Distance

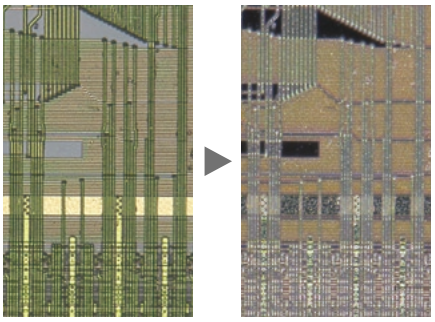
The VH-Z50L has an observation distance of 85 mm 3.35" at 500x magnification. Thanks to a sophisticated lens design, this lens allows distant targets to be observed in high-magnification, inconceivable with conventional optical microscopy. By coupling a large diameter objective lens with advanced assembly techniques and the latest in illumination technology, the VH-Z50L achieves three times the depth of field of conventional lenses, well beyond the limits of the conventional microscope.

Z50L/W OPTICAL ADAPTER



RING ILLUMINATION

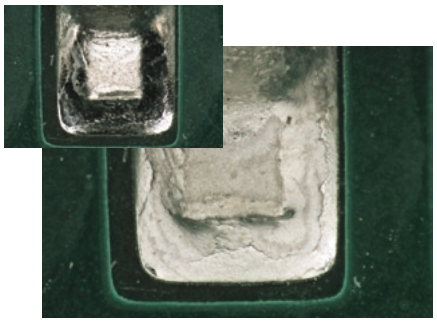
971927



IC (500x)

DIFFUSE ILLUMINATION

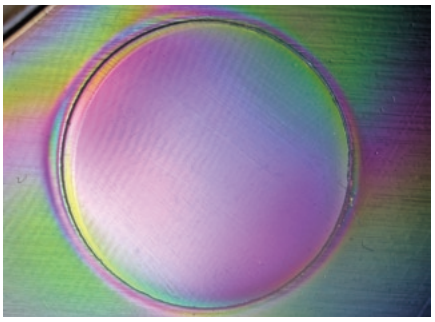
971929



Soldering (200x)

POLARIZED ILLUMINATION

971930



Plastic gate section (50x)

OPTIONS

Fiber cables

OP-31207
OP-51480

Polarized illumination adapter

OP-72406
OP-72407

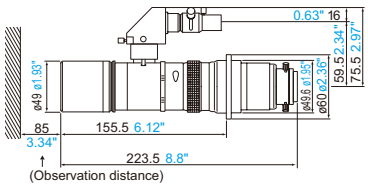
LENS PERFORMANCE

Magnification [1]		50x	100x	200x	300x	400x	500x
Monitoring range (mm inch)	Horizontal	6.09 0.24"	3.05 0.12"	1.53 0.06"	1.02 0.04"	0.76 0.03"	0.61 0.02"
	Vertical	4.57 0.18"	2.28 0.09"	1.14 0.04"	0.76 0.03"	0.57 0.02"	0.46 0.02"
	Diagonal	7.62 0.30"	3.81 0.15"	1.90 0.07"	1.27 0.05"	0.95 0.04"	0.76 0.03"
Observation distance (mm inch)		85.0 3.35"					

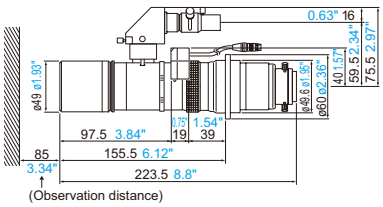
1. Magnification on a 15-inch monitor.

DIMENSIONS

VH-Z50L



VH-Z50W



ZOOM LENS 25 ▸ 175

VH-Z25

A single lens unit covers 25x to 175x magnification

The VH-Z25 can continuously change magnification from 25x to 175x without the need for lens replacement. You can quickly find an observation point at low magnification and then directly zoom in on the observation point. The VH-Z25 provides two types of illumination heads (contact type and non-contact type) as standard equipment. The non-contact type illumination head provides an observation distance of 25.5 mm 1.00", improving your operating efficiency.

LENS PERFORMANCE

Magnification[1]		25x	50x	100x	175x
Monitoring range (mm inch)	Horizontal	12.20 0.48"	6.10 0.24"	3.05 0.12"	1.74 0.07"
	Vertical	9.10 0.36"	4.55 0.18"	2.28 0.09"	1.30 0.05"
	Diagonal	15.24 0.6 "	7.62 0.3"	3.81 0.15"	2.18 0.09"
Depth of field (mm inch)		13.0 0.51"	3.0 0.12"	0.7 0.03"	0.3 0.01"
Observation distance (mm inch)		25.5 1.00"			

1. Magnification on a 15-inch monitor.

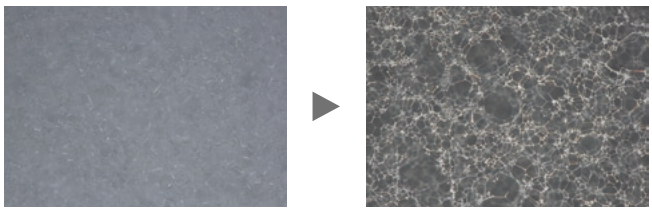
OPTIONS

Variable illumination adapter

The variable illumination adapter is attached to the end of the lens and has a ring that, when turned, changes the incident angle of light from vertical to flanking illumination (approx. 10 degrees). This allows easier observation of minute height differences or scratches.

VH-K20

Sponge (50x)



Standard illumination — Variable illumination

Coaxial vertical adapter

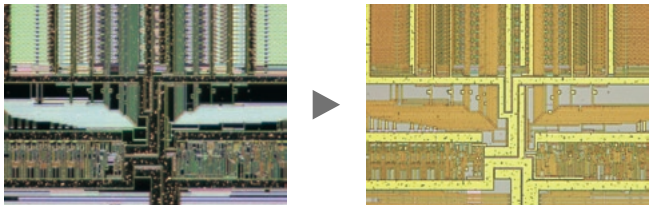
This adapter uses a half mirror to align the axis of light illuminated on the target with the optical axis of the lens. This increases the amount of regular reflection and is used for bright-field observation.

OP-35416

OP-94841

OP-51482

IC circuit (1000x)



Without adapter (dark-field) — With adapter (bright-field)

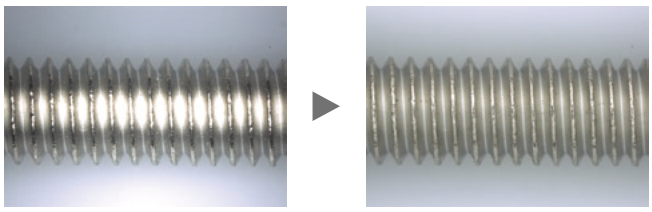
Diffused illumination adapter

The diffused illumination adapter is attached to the end of the lens to provide an even amount of light over the target. It uses a frosted optical filter to diffuse the domed light source.

OP-42305 OP-35414

OP-35469 OP-35324

Screw threads (30x)



Standard illumination — Diffused illumination

Polarized illumination adapter

Passing polarized illumination through a polarized filter turned 90 degrees cuts only regular reflected light.

OP-35415

Coated surface (200x)

Standard illumination — Polarized illumination

Free head

OP-32348

Contact adapter

OP-98749

Non-contact adapter

OP-98748

LONG-FOCAL-DISTANCE ZOOM LENS

35 ▸ 245

VH-Z35

35x to 245x magnification at a distance of 54 mm 2.13"

With a observation distance of 54 mm 2.13" and extremely large depth-of-field, this lens provides a convenient way to monitor a target with height differences on the surface and greatly increases monitoring efficiency. With a single lens, you can view from a low magnification (35x) to a high magnification (245x), allowing the desired point to be quickly enlarged.

OPTION

Coaxial vertical illumination adapter

OP-35416

LENS PERFORMANCE

Magnification [1]		30x	50x	100x	150x	200x	245x
Monitoring range (mm inch)	Horizontal	8.71 0.34"	6.10 0.24"	3.05 0.12"	2.03 0.08"	1.53 0.06"	1.24 0.04"
	Vertical	6.50 0.26"	4.55 0.18"	2.28 0.09"	1.52 0.05"	1.14 0.04"	0.93 0.04"
	Diagonal	10.89 0.43"	7.62 0.3"	3.81 0.15"	2.54 0.1"	1.90 0.07"	1.56 0.06"
Depth of field (mm inch)		8.3 0.33"	5.0 0.2"	1.0 0.04"	0.5 0.02"	0.4 0.02"	0.3 0.01"
Observation distance (mm inch)		54.0 2.13"					

1. Magnification on a 15-inch monitor.

MIDDLE-RANGE ZOOM LENS

150 ▸ 800

VH-Z150

150x to 800x magnification, ideal for monitoring reflective surfaces

This middle-range zoom lens allows continuous changes in magnification of between 150x and 800x. It can be used to monitor at a distance 12 mm 0.47" at 800x magnification. The illumination head can be switched to a coaxial vertical illumination type to enable detailed observation of microstructure of metal or a semiconductor surface.

OPTION

Adjustable illumination adapter

VH-K150

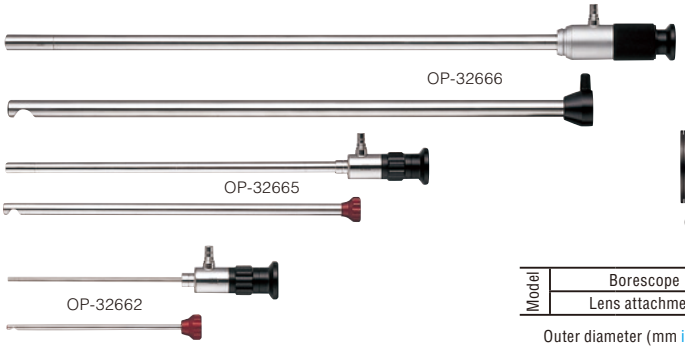
LENS PERFORMANCE

Magnification [1]		150x	200x	500x	800x
Monitoring range (mm inch)	Horizontal	2.03 0.07"	1.53 0.06"	0.61 0.02"	0.38 0.014"
	Vertical	1.52 0.06"	1.14 0.04"	0.46 0.02"	0.28 0.011"
	Diagonal	2.54 0.1"	1.90 0.07"	0.76 0.03"	0.48 0.018"
Observation distance (mm inch)		12.0 0.47" [2]			

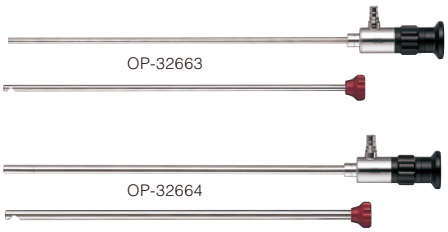
1. Magnification on a 15-inch monitor.
1. 6.5 mm 0.25" when the coaxial vertical illumination ring is attached.

BORESCOPE LENS

OP-32662/32663/32664/32665/32666




OP-32681



Two observation directions (direct view and lateral view) with a single unit

The borescope unit provides a 90° lateral view attachment as standard equipment, enabling observation directions to be switched between direct view and lateral view. Five types of bore diameters are available, allowing you to select an appropriate diameter according to your observation purpose. The monitoring magnification is 80x to 360x, 1.2 to 5 times larger than conventional models. You can even clearly observe minute targets that cannot be observed with conventional models.

Model		OP-32662		OP-32663		OP-32664		OP-32665		OP-32666	
Lens attachment		OP-32681									
Outer diameter (mm inch)		ø4.0 ø0.16"	ø4.4 ø0.17""	ø5.5 ø0.22"	ø5.9 ø0.23"	ø8.0 ø0.31"	ø8.5 ø0.33"	ø10 ø0.39"	ø10.5 ø0.42"	ø14 ø0.55"	ø15 ø0.59"
Effective length (mm inch)		135 5.31"		250 9.84"		250 9.84"		250 9.84"		420 16.53"	
View direction [1]	Direct view	0°		0°		0°		0°		0°	
	Lateral view	90°		90°		90°		90°		90°	
View angle		35°		40°							
Observation distance (mm inch)		2.5 to ∞ 0.10" to ∞		2.7 to ∞ 0.11" to ∞		3.5 to ∞ 0.14" to ∞		2.7 to ∞ 0.11" to ∞		10 to ∞ 0.39" to ∞	
Maximum observation magnification [2]		230x		360x		175x		190x		80x	
Minimum view range [3]		1.1 0.04"		0.7 0.03"		1.5 0.06"		1.4 0.06"		3.3 0.13"	
Ambient temperature		Sleeve: 0 to 80°C 32 to 176°F except for sleeve: 0 to 40°C 32 to 104°F									

1. 0°: When the direct-view standard lens is attached. 90°: When the lateral-view attachment is attached.
2. Magnification around the center of the 15-inch monitor screen.
3. Horizontal view range.

*OP-33242(fiber cable),OP-51482(VHX adapter),OP-51647(bayonet adapter D) and OP-32681(lens attachment) needed for these lenses.

BORESCOPE LENS

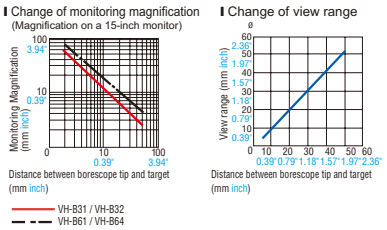
VH-B31/B32/B61/B64


VH-B

ø3 mm ø0.12" sleeve for viewing inside a narrow gap

The 3 mm 0.12" sleeve diameter enables you to easily monitor inside a narrow gap or complicated shape. Select from two types of end shapes. Direct-view and oblique-view. Only the lens is contained in the sleeve, enabling excellent resolution. The borescope lens is completely waterproof for underwater observation.

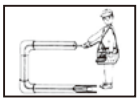
*In addition to the above, many size variations are available.
For more information, contact the nearest KEYENCE sales office.

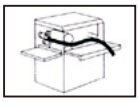


Model	Borescope	VH-B31	VH-B32	VH-B61	VH-B64
	Lens attachment	VH-B			
Outer diameter (mm inch)		ø3 ø0.12" (Protective tube: ø4 ø0.16")		ø6 ø0.24"	
Effective length (mm inch)		105 4.13"	107 4.21"	300 11.81"	304 11.97"
View direction		0° (direct view)	30° (oblique view)	0° (direct view)	70° (oblique view)
View angle		55°			
Observation depth (mm inch)		2 to 50 0.08" to 1.97"			
View range (mm inch)		ø2 to ø52 ø0.08" to ø2.05"			
Protection		Sleeve: Waterproof			
Ambient temperature		0 to 40°C 32 to 104°F (in air/water)			

FIBERSCOPE

VH-F61/F111


Inspecting pipes


Inspecting the inside of a photocopier

Monitoring a complicated shape

The fiberscope allows you to monitor places where conventional lenses cannot be used, such as the inside of a complicated machine or a narrow, bending pipe. You can even monitor blind spots by changing the angle of the tip of the fiberscope remotely.

Model	Borescope	VH-F61	VH-F111
	Lens attachment	VH-F	
Outer diameter (mm inch)		ø6.1 ø0.24"	ø11 ø0.43"
Effective length (mm inch)		1000 39.37"	1500 59.06"
View direction		Direct view	
View angle		65°	55°
Observation depth (mm inch)		10 to ∞ 0.39" to ∞	20 to ∞ 0.79" to ∞
Bendable sleeve angle		120° up/down	120° up/down, 100° right/left
Ambient temperature		10 to 80°C 50 to 176°F	
Operating atmospheric pressure		1 atm	
Oil & waterproof		Machine oil and light oil	

LONG-FOCAL-DISTANCE LENS

VH-W50/W100/W200

VH-W50 (50x)

VH-W100 (100x)

VH-W200 (200x)

Lateral illumination adapter
(Optional for VH-W100/W200)
OP-98535

Working while monitoring the target

The long-focal-distance lens provides a long observation distance of 60 to 78 mm 2.36" to 3.07", allowing you to continue working while monitoring a target. You can view clear images even when close monitoring is impossible, such as a target in a recess or the presence of a glass plate between the lens and target.

Model		VH-W50	VH-W100	VH-W200
Magnification [1]		50x	100x	200x
Monitoring range (mm inch)	Horizontal	6.10 0.24"	3.05 0.12"	1.53 0.06"
	Vertical	4.55 0.18"	2.28 0.09"	1.14 0.04"
	Diagonal	7.62 0.30"	3.81 0.15"	1.90 0.07"
Depth of field (mm inch)		3.1 0.12"	0.6 0.02"	0.3 0.01"
Observation distance (mm inch) [*2]		78(77) 3.07"(3.03")	60(59) 2.36"(2.32")	60(59) 2.36"(2.32")

1. Magnification on a 15-inch monitor.
2. Figures in parentheses are applicable when a non-reflective illumination head is used.

HYPER-VIEW LENS

VH-V100/V200

VH-V100 (100x)

VH-V200 (200x)

Model		VH-V100	VH-V200
Magnification [1]		100x	200x
Monitoring range (mm inch)	Horizontal	3.05 0.12"	1.53 0.06"
	Vertical	2.28 0.09"	1.14 0.04"
	Diagonal	3.81 0.15"	1.90 0.07"
Depth of field (mm inch)		1.0 0.04"	0.4 0.02"

1. Magnification on a 15-inch monitor.

Easy monitoring of a glossy target with minimum glare

The hyper-view lens suppresses glare from a glossy surface, enabling detailed monitoring. You can easily detect a flaw, stain or crack on metal, glass or ceramic surfaces that are difficult to detect using conventional microscopes.

VERTICAL-ILLUMINATION LENS

VH-C501/C1001

VH-C501

VH-C1001

Model		VH-C501	VH-C1001
Magnification [*1]		500x	1000x
Monitoring range (mm inch)	Horizontal	0.61 0.02"	0.31 0.01"
	Vertical	0.46 0.02"	0.23 0.01"
	Diagonal	0.76 0.03"	0.38 0.01"
Depth of field (mm inch)		1.0 0.04"	0.4 0.02"
Observation distance (mm inch)		0 to 2.0 0" to 0.08"	0 to 2.0 0" to 0.08"

1. Magnification on a 15-inch monitor.

Monitoring metal surfaces

The vertical-illumination lens utilizes our original optical system to give it a thin body. You can clearly monitor microstructure of metal or a semiconductor surface, which are hard to see using conventional lateral illumination. Two models are available with magnification factors 500x and 1000x.

FIXED-MAGNIFICATION LENS

VH-20/50/100/200/501/1001

VH-20

VH-50

VH-100

VH-200

VH-501

VH-1001

Model		VH-20	VH-50	VH-100	VH-200	VH-501	VH-1001
Magnification [1]		20x	50x	100x	200x	500x	1000x
Monitoring range (mm inch)	Horizontal	15.25 0.60"	6.10 0.24"	3.05 0.12"	1.53 0.06"	0.61 0.02"	0.3 0.01"
	Vertical	11.38 0.45"	4.55 0.18"	2.28 0.09"	1.14 0.04"	0.46 0.02"	0.23 0.01"
	Diagonal	19.05 0.75"	7.62 0.3"	3.81 0.15"	1.90 0.07"	0.76 0.03"	0.38 0.01"
Depth of field (mm inch)		12.0 0.47"	6.5 0.26"	1.0 0.04"	0.4 0.02"	0.06 0.002"	0.03 0.001"
Observation distance of non- contact type (mm inch)		70(62) [2] 2.76"(2.44")	12.5 0.50"	11.0 0.43"	3.5 0.14"	3.5 0.14"	3.5 0.14"

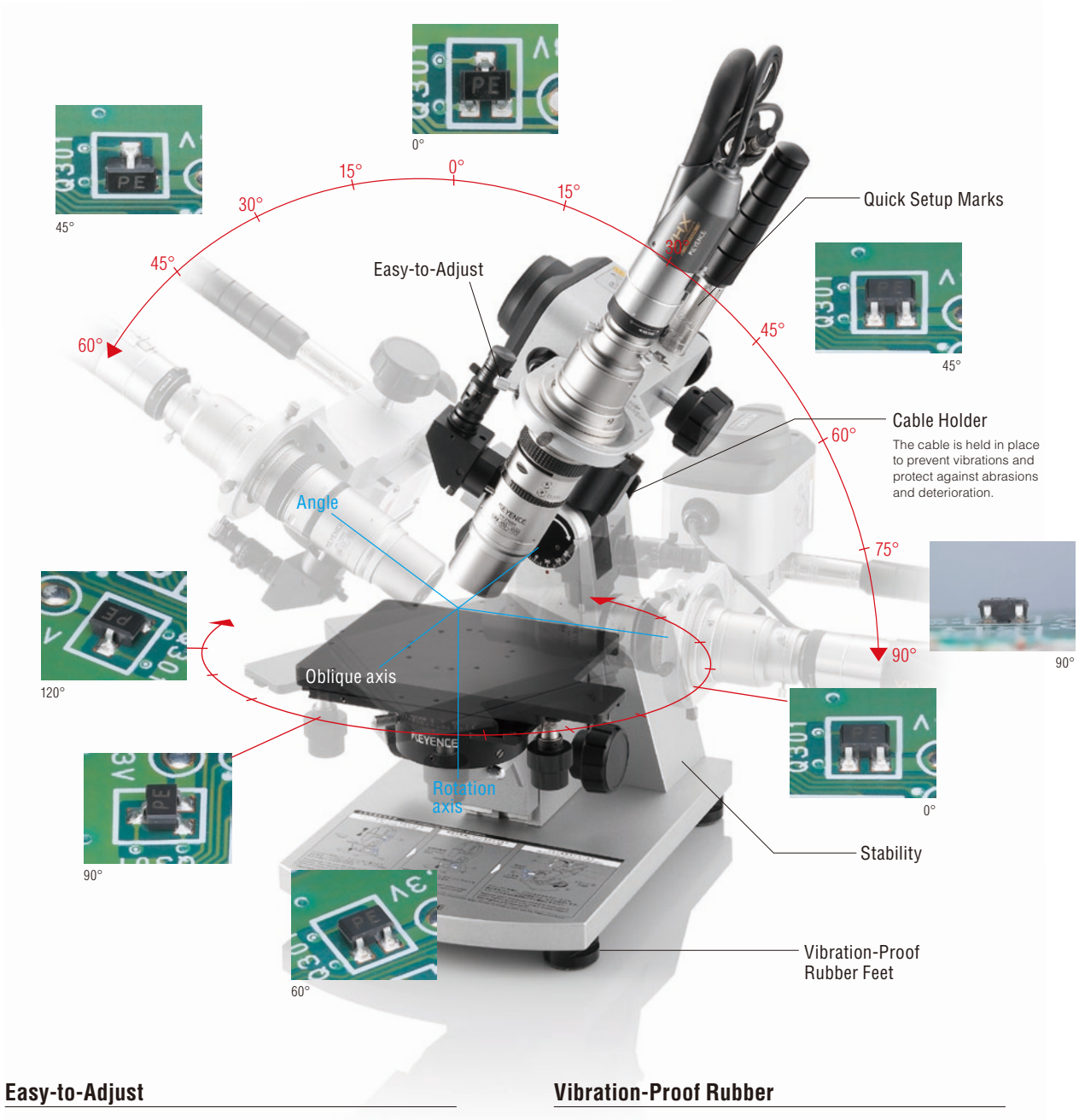
1. Magnification on a 15-inch monitor.
2. The figure in parentheses is applicable when a non-reflective illumination head is used.

Lens selection based on desired magnification

Select your desired magnification between 20x and 1000x. These fixed-magnification lenses provide a larger depth-of-field than conventional microscopes, enabling you to obtain a sharp 3D image. Two types of illumination heads are included: Contact and non-contact (except for VH-20).

VHX-S50

Simple, versatile and intuitive operation - Motorized Free-Angle Stand



Easy-to-Adjust

Easy focus adjustment, X-Y stage movement, rotation and oblique axis motion. A custom mechanism allows the target to stay centered in the field of view, even when the lens unit is inclined or rotated.

Quick Setup Marks

The ideal setting position for different lenses is indicated on the arm.

Stability

The die-cast main body provides a highly rigid structure that allows for more stable observations.

Vibration-Proof Rubber

Absorbs low to high frequency vibration, allowing for observation of specimens without interference.

SPECIFICATIONS

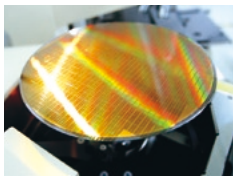
Model	VHX-S50/VHX-S50F
Applicable lens	VH-Z00R/W, VH-20R/W, VH-Z50L/W, VH-Z100R/W, VH-Z100UR/UW, etc.
Stage stroke distance	Electric: 29 mm 1.14", Manual: 33 mm 1.30"
Motor	2-phase stepping motor
Resolution	1 µm (typ)
Ambient temperature	5 to 40°C 41 to 104°F
Relative humidity	35 to 80%, No condensation
Weight	13.5 kg (VHX-S50), 2.5 kg (VHX-S50F)

VH-S5

High stability through a low center of gravity

Excellent vibration protection

A special vibration proof material has been selected to insulate the VH-S30/S5. It is designed to absorb a broad range of vibrations in order to provide stable images of highly magnified objects.



Anti-Vibration System

Stability

3-Axis Rotation Mechanism

Vibration-Proof Rubber

Vibration-Proof Rubber

A special vibration proof material has been selected to insulate the VH-S30/S5. It is designed to absorb a broad range of vibrations in order to provide stable images of highly magnified objects.

Anti-Vibration System

The cable is tightly held in place, completely eliminating subtle vibrations during high-magnification observation.

3-Axis (X/Y/θ) Rotation Mechanism

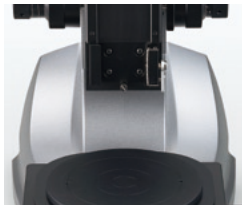
This mechanism helps everyone to perform fine position adjustments in high-magnification observations. Furthermore, removing the stage enables transmitted illumination.

Aluminum Die Casting

Aluminum die casting is the process of forcing molten aluminum under high pressure into mold cavities. It allows for the creation of high precision casts, such as automotive components and precision machinery parts.

Stability

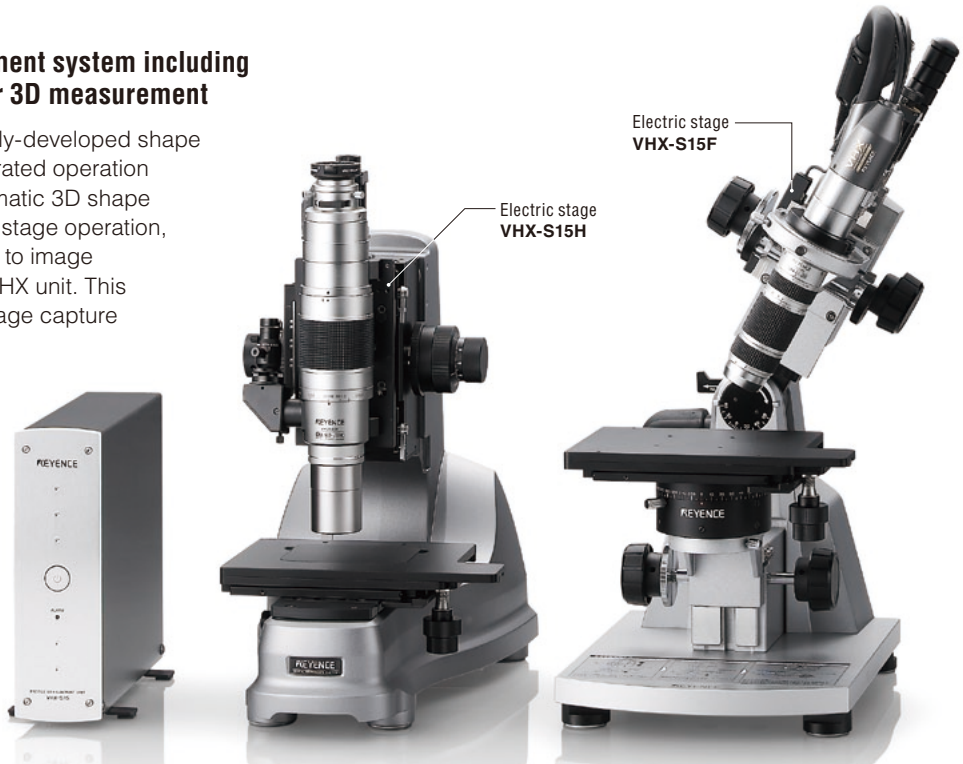
The die-cast main body provides a highly rigid structure that allows for more stable observations.



VHX-S15 Series

All-in-one 3D profile measurement system including a precision motorized stage for 3D measurement

The precision linear stage and newly-developed shape measurement functions allow integrated operation of magnified observation and automatic 3D shape measurement. All of the steps from stage operation, magnified observation, 3D analysis to image saving can be controlled with the VHX unit. This integration significantly reduces image capture and analysis time.



Controller
VHX-S15CE

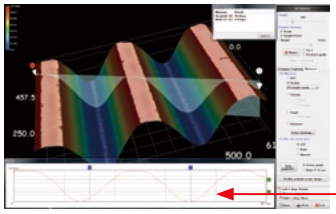
Vibration-resistant, high-magnification observation system
VH-S5

Free-angle observation system
VH-S30

Easy, on-screen 3D profile measurement*

The VHX Series creates a 3D image based on automatically captured images, and it calculates height profile data on a desired measuring line. Height, width and height difference data on the measuring line are plotted on a graph. Since the profile graph is related to the cursor position in the image display area, you can see the current measuring point easily.

*The function of optional measurement software.



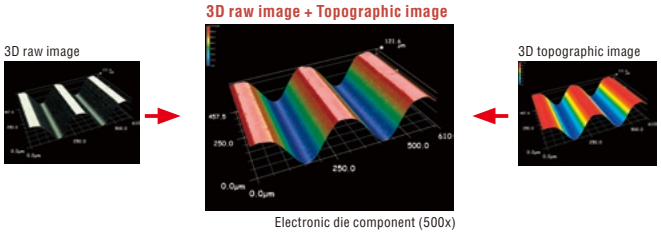
With the horizontal/vertical cursor, the height and width can be measured. The 2-line comparative mode can simultaneously display comparative analysis profile data on two parallel lines.

Electronic die component (500x)

Color topographical overlay allows you to see height differences at a glance*

Color bars that indicate height are displayed on a 3D image. The highest position is displayed in red, and the lowest position is displayed in blue, allowing you to see a height difference at a glance. The height data can be superimposed on a raw image. Furthermore, the X-axis, Y-axis and Z-axis scales are calculated automatically and displayed according to the image size and the 3D rotation angle.

*The function of optional measurement software.



Electronic die component (500x)

SPECIFICATIONS

Model		VHX-S15CE/H (VHX-S15F) [2.]
Stage stroke distance		15 mm 0.59"
Motor		5-phase stepping motor
Resolution		0.05 µm 0.002 mil/pulse
Positioning accuracy [1.]		6 µm 0.23 mil
Repeatability [1.]		±0.5 µm ±0.02 mil
Ratings	Power supply voltage	100 to 240 VAC, 50/60 Hz
	Power consumption	70 VA
Ambient temperature		5 to 40°C 41 to 104°F
Relative humidity		35 to 80%, No condensation
Weight		VHX-S15CE (Controller): 3 kg, VHX-S15H (Electric stage): 1.3 kg, VHX-S15F (Electric stage): 3.2 kg
Load capacity		5 kg

1. Positioning accuracy and repeatability specifications apply to the motorized stage
2. The motorized stage for the VH-S30 is the VHX-S15F.

OPTION

Digital indicator set

OP-51610

Digital indicator for direct measurement of the lens stroke distance, ensuring easy calibration.

VH-M100 Series NEW

The Measuring Microscope System for measuring with fine precision on all microscopes

Stage meets traceability requirements of international standards

Measures over long strokes with fine precision. The stage travel can also be calibrated, just like stages for conventional measuring microscopes.

Measurement range of 100 x 100 mm 3.94" x 3.94" measures large workpieces

The VH-M100 measures the travel of the work-mounted stage as it moves by turning X and Y handles. Large workpieces that were outside the view of conventional microscopes can also be measured.

X-Y measurement system
VH-M100

SPECIFICATIONS

Model		VH-M100
Stage stroke distance		100 mm (3.94") in the X and Y directions, respectively
Display resolution		0.1 µm
Movement accuracy		4 + 0.02L (µm)*
Ratings	Power supply voltage	100 to 240 VAC 50/60 Hz
	Current consumption	50 VA
Environmental resistance	Ambient temperature	5 to 40°C 41 to 104°F
	Relative humidity	35 to 80%, No condensation
Weight		18 kg
Load capacity		3 kg

* "L" means movement distance (mm).

OPTION

Transmission illumination unit
OP-84484
Clearly projects edges of a target.

Display unit
OP-84483
The display unit is useful when the moved distance cannot be confirmed on the monitor.

For the VH-M100
Lens holder
(For manual low-power zoom)
OP-84486

For the VH-M100
Lens holder
(For manual high-power zoom)
OP-84487

Lens holder for the VH-M100
(For motorized zoom)
OP-84488

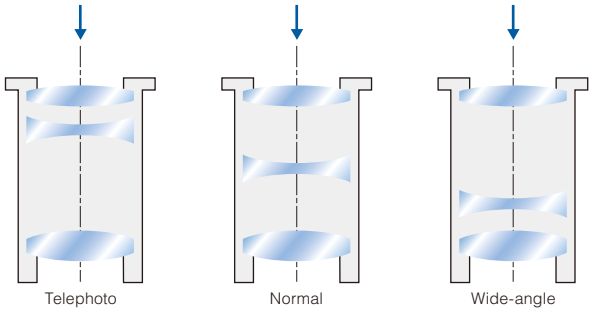
ZOOM LENS

A zoom lens allows for fast observation as the magnification can be adjusted by simply rotating a zoom ring. A typical microscope is equipped with only 3 to 4 different lenses to choose from, but a zoom lens can be gradually adjusted from low to high magnification. It is more compact and less costly than using several lenses.

Operation of A Zoom Lens

In optical discussions, a single lens is called a "simple lens", while a lens designed with added functionality using multiple lenses is called a "compound lens". KEYENCE lenses are made of complex lenses using sophisticated lens design technology to dramatically increase their functionality. In a zoom lens, the distance between each constituent lens is changed to alter the focal length which, in turn, makes the lens wide-angle or telephoto.

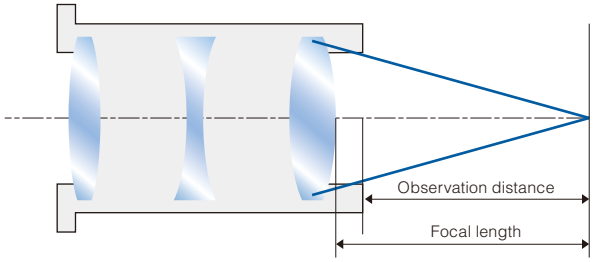
Design of a zoom lens



Focal Length and Observation distance

The focal length refers to the distance between the target and the lens when the lens is in focus and the target appears clearest. Observation distance, also known as working distance (WD), refers to the distance from the tip of the lens (including lighting adapters, etc.) to the target. Observation distance is slightly shorter than the focal length. Accordingly, more attention is paid to observation distance in a lens specification.

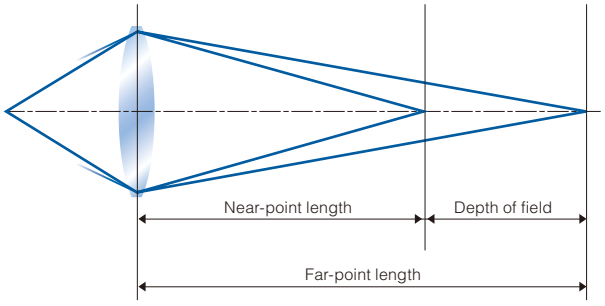
Focal length and observation distance



Depth of Field

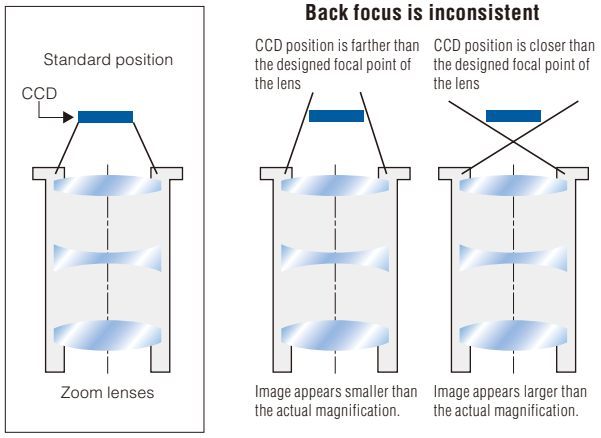
When observing an object with a lens, the object is most clearly observed when it is at the focal position of the lens. If the distance between the object and the lens is slightly changed, it can still be clearly observed within a tolerance area. The tolerance within which the object is in focus is called the depth-of-field. A lens with large tolerance has a large depth-of-field and a lens with little tolerance has a shallow depth-of-field. When using a lens with a large depth-of-field, it is possible to precisely and quickly observe an entire object with projections and depressions.

Diagram of depth of field



Back Focus

Back focus refers to the distance from the surface of the camera to the focal point of the optical lens. The back focus on all KEYENCE zoom lenses is designed to be a fixed length. Therefore, it is possible to always observe at the same working distance and magnification reference, saving time and eliminating measurement errors caused by back focus.



Optical Aberration

The image formed by light that actually passes through the lens differs slightly from the ideal image. This difference is called aberration. Aberration causes the image to form at a different point which can impart coloration to the image or blur the color of the image. The image may develop a tail that extends from the axis of light or it may appear distorted. As such, the less aberration a lens has, the better it is considered to be. Aberration is commonly more pronounced at the periphery than at the center. While it is not possible to completely eliminate aberration, it is possible to reduce degradation of the picture quality by using a combination of multiple lenses made of materials with properties to cancel the effects of aberration.

Chromatic Aberration

White colored light is a combination of various colors. When light passes through a lens, the refractive index of each color in the light differs, thus causing different convergence positions. This effect is called chromatic aberration. A lens with chromatic aberration will cause the colors away from the center of the screen to bleed.

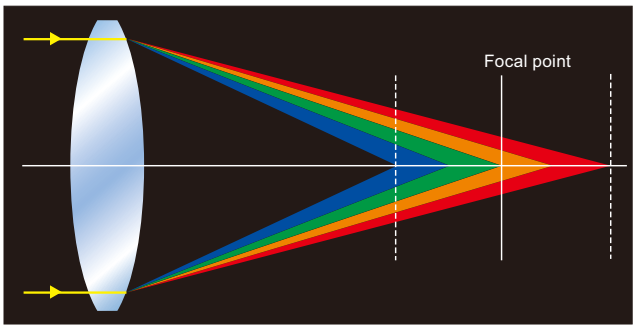
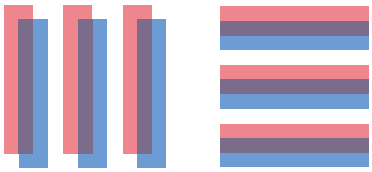


Chart image when there is chromatic aberration
(Image for reference purposes only)



To reduce chromatic aberration, a convex lens that has a low refractive index for color can be used with a concave lens that has a high refractive index for color, or a combination of multiple lenses made from different materials can be used.

Fluorite Lens

Lenses are commonly made from optical glass, a type of glass that has a uniform refractive index and low light absorption. In addition to glass, natural elements such as crystal may be used. There are various types of crystal, with fluorite (CaF2) considered particularly suitable for lens-making.

Crystal/quartz (Sio2) Crystal is a quartz with a high crystalline structure. It is colorless and transparent, and light passes through it easily. Today, it can be made through artificial means and is actually used to make optical fiber.
Fluorite (CaF2) Fluorite is characterized by its ability to pass light of long wavelengths, and is good at passing light from ultra-violet to infra-red. Although it is ideal for lens-making, fluorite is relatively expensive due to its rarity and processing difficulty.
Halite (NaCl), Silicon (Si), Germanium (Ge) These elements pass infra-red rays well, and are traditionally used in infra-red equipment designed to analyze matter.

When fluorite is made into a lens, it removes residual chromatic aberration (secondary spectrum) which is what disturbs the sharpness in a captured image. Compared to an optical glass lens, the refractive index is lower so the lens has extremely low dispersion.

Numerical Aperture (N.A.)

Often abbreviated as "N.A.", its value indicates the brightness and resolution of the optical system. Numerical aperture is defined as follows:

NA = N sin θ

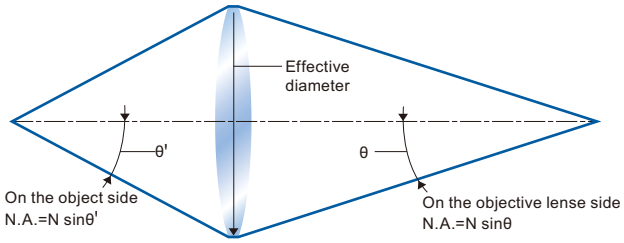
where N is the refractive index of the medium around the target (N = 1 in air)

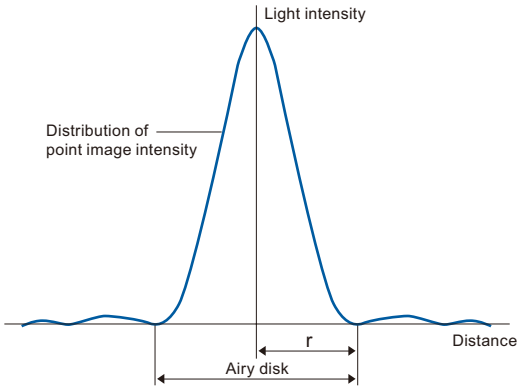
Light exhibits a wave-like spreading effect known as diffraction. This is what causes it to spread in a disk-shaped pattern rather than converging at a single point even when a high-performance lens with no aberration is used. Numerical aperture indicates the light-condensing limit or diffraction limit of a lens without optical aberration, a concept thought to come from light's wave-like behavior. This disk-shaped wave is called an Airy disk. The radius r (width) of an Airy disk is calculated using the formula below.

r = 0.61λ/N.A.
(λ: wavelength of light, N.A.: numerical aperture, 0.61: constant)

The value derived using this formula is called "resolution". Based on this formula, the larger the numerical aperture the smaller the radius of the Airy disk, which implies that a larger numerical aperture will produce a sharper image. This is a common criterion used to evaluate lenses.

Figure defining numerical aperture





Radius of Airy disk $r = \frac{0.61\lambda}{N.A.}$

LENS PRODUCTION

It takes many steps to produce a lens product. Polishing is not the only factor that determines the performance and quality of a lens. Rather, it is the culmination of each step taken to make the lens. This is why all KEYENCE lenses are made using an integrated process.

1. Optical and Mechanical Design

The lens system, from simple lenses to compound lenses, is assembled using computer simulation. The mechanical design for the lens tube and zoom mechanism is made to match the lens system. To produce a lens that meets the level of sophistication afforded by computer-based optical designs, polishing, machining, and assembly technology is also required.

2. Optical Glass Material

Most optical glasses are cylindrical before grinding. The cylinder is sliced into disks and then goes through a machining process. The KEYENCE RZ lens uses materials with various optical properties, each designed to contribute to forming an ideal image. The optical glass still lacks transparency at this stage.

3. Rough Cut

This process cuts the glass disks into lens blanks. Machines such as the Oscar grinder and curve generators are used to grind the lens to its rough radius of curvature, dimension, and shape. The Oscar grinder uses a polishing disk made by pouring coal tar, called pitch, on the polishing plate. At this stage, the lens still has a frosted appearance.

4. Grinding Using Pellets and Resin

Pellets are abrasive grains made of diamonds that are implanted on a small, thin, disk-shaped grindstone. Several of these grindstones are cemented to the disk to polish the lens. Next, a resin grindstone is used to polish the lens further.

5. Polishing

This process uses an abrasive to polish the surface of the lens more delicately. The lens is finished by repeatedly polishing and checking the mirror surface finish. The finished lens will be clear after this process. The most important point during lens polishing is, in addition to the abrasive, the use of temperature-controlled water. Failure to keep the water at the optimum temperature will result in a lens surface that does not meet the design specifications. The surface finish is measured using an interferometer.

6. Cleaning

After the polishing process is done, the lens is put through an ultrasonic cleaner to remove abrasives and other matter.

7. Centering

This is the final polishing stage. The center of the lens is clamped in the cutting machine and spun at high speed while the periphery is ground so that the optical axis centers in the lens.

8. Coating

The lens is coated to prevent diffuse reflection and improve light transmittance. A vacuum depositor located in the clean room is used to deposit the coating on the lens. This treatment is what makes the lens transmit only light of a fixed wavelength.

9. Assembly

The completed lenses are now assembled in a clean room into a single lens by one technician. To ensure the lens resolves highly from low to high magnification, not only must each lens be precision-made, they must also be assembled with precise skill to ensure they are concentric and free of play when zoomed.

10. Final Inspection

The lens must pass more than 20 final inspection tests before it can be shipped as an "RZ Lens".

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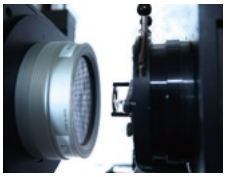

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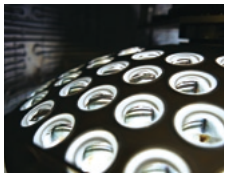

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SAFETY INFORMATION
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