

Microscope Components

16

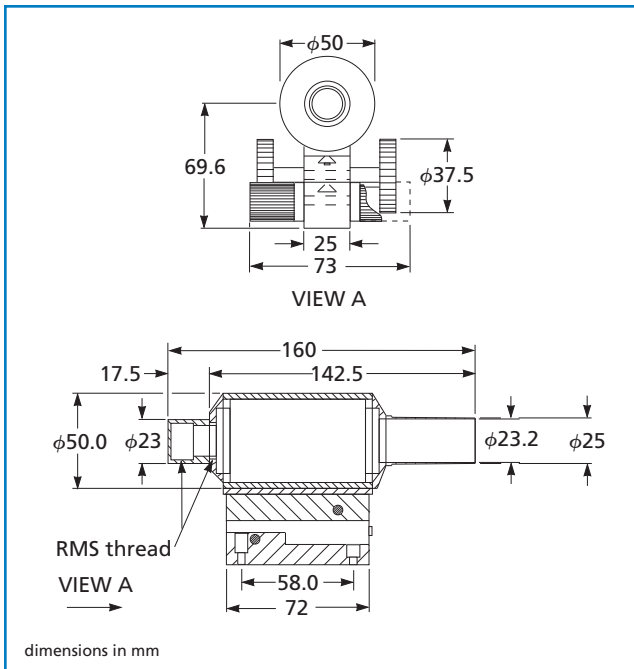


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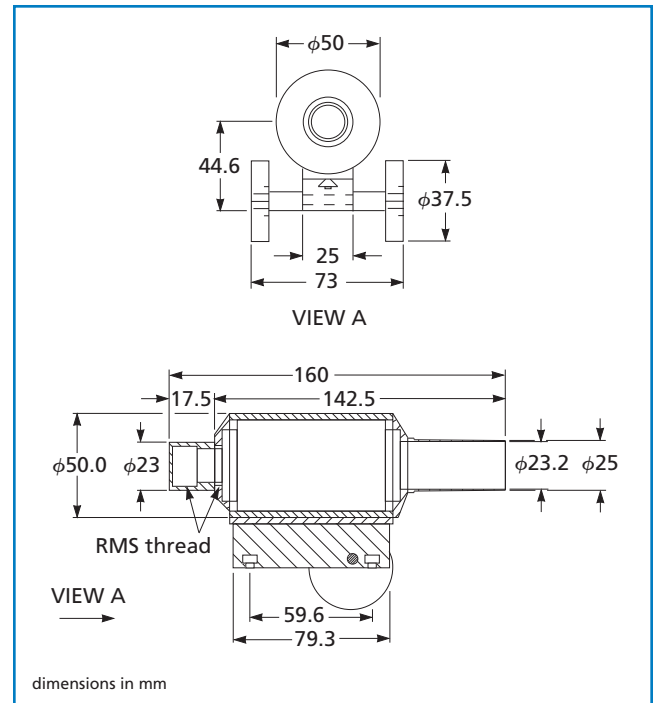
CVI Melles Griot microscope bodies are ideal for custom applications that involve optical component testing, metrology, biology, image capture, and semiconductor inspection.

- These bodies accept RMS-threaded (0.8 in., 36 TPI) objective lenses.
- An optional objective turret can hold up to three microscope objectives.
- The coarse-focusing microscope body is suitable for objective lenses with power up to $16\times$. The fine-focusing body is recommended for higher power objective lenses.
- Antibacklash gears eliminate positional hysteresis.
- The bodies allow 63 mm of coarse travel range with $100\text{-}\mu\text{m}$ resolution.
- A fine-focusing mechanism provides 3 mm of travel with $4\text{-}\mu\text{m}$ resolution.
- The housing and tube are black anodized. The slideways are brass, and the drive mechanism is steel.



04 TFF 002 microscope focusing body

Microscope Focusing Bodies



04 TCF 002 microscope focusing body

Microscope Focusing Bodies

Coarse Focus	Fine Focus	PART NUMBER
Yes	No	04 TCF 002
Yes	Yes	04 TFF 002



CVI Melles Griot microscope body accessories include adjustable and angular eyepiece holders, a turret lens mount, focusing stages, and a microscope mounting plate.

Adjustable Eyepiece Holder

The adjustable eyepiece holder allows the user to vary adjustment of microscope length to change magnification. It is not recommended for use with an objective whose NA is greater than 0.5.

- Length can be varied from 140 mm to 200 mm.
- The eyepiece tube is chrome-plated brass. The mounting plate is black-anodized aluminum.

Adjustable Eyepiece Holder

	PART NUMBER
Adjustable Eyepiece Holder	04 AEH 002

Turret Lens Mount

The CVI Melles Griot chrome-plated-brass turret lens mount makes changing the objective fast and convenient. It is available for three objectives. To maintain the overall tube length at 160 mm, remove the extension ring from the microscope body.

Turret Lens Mount

Objective Capacity	PART NUMBER
3	04 NOP 003

Microscope Body Accessories

Angular Eyepiece Holder



04 AEH 004 angular eyepiece holder

The angular eyepiece holder has a built-in prismatic system that bends light 45 degrees. The eyepiece can be rotated to provide greater comfort in difficult or prolonged viewing situations. This holder replaces the straight eyepiece holder on standard microscope bodies.

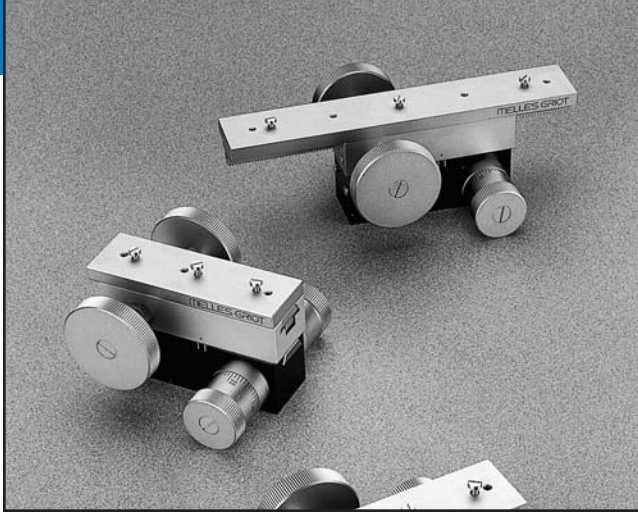
- The offset angle is 45 degrees.
- The eyepiece tube is chrome-plated brass. The mounting plate is black-anodized aluminum.

Angular Eyepiece Holder

	PART NUMBER
Angular Eyepiece Holder	04 AEH 004



Microscope body accessories



Focusing Stages

These focusing mechanisms are designed for applications that require precise, smooth, and controlled motion of optical components and sub-systems. Holes are provided for attaching the stages to microscopes and mounting plates.

- Modules are available with a coarse and fine travel range of either 63 mm or 125 mm. Both provide 100- μ m resolution.
- The fine-focus range is 3 mm with 4- μ m resolution.
- The stages are constructed of chrome-plated brass with a steel drive mechanism.

Focusing Stages

Travel Range (mm)	Coarse Focus	Fine Focus	PART NUMBER
63	Yes	Yes	04 MFF 001
125	Yes	Yes	04 MFF 003

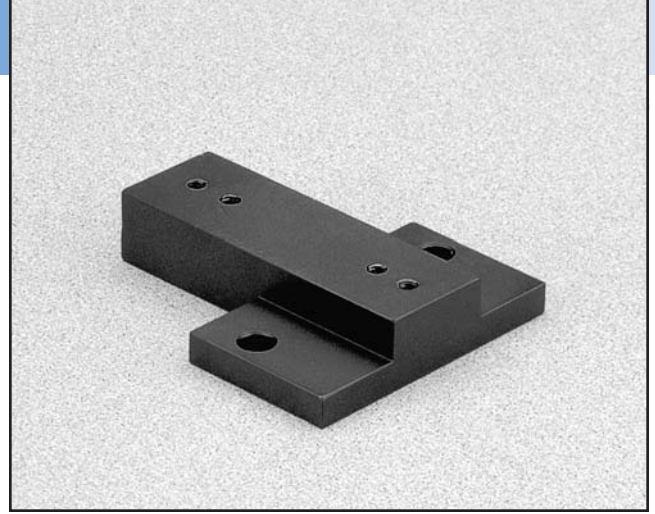
C-Mount Camera Adaptor



07 ACM 001 C-mount camera adaptor

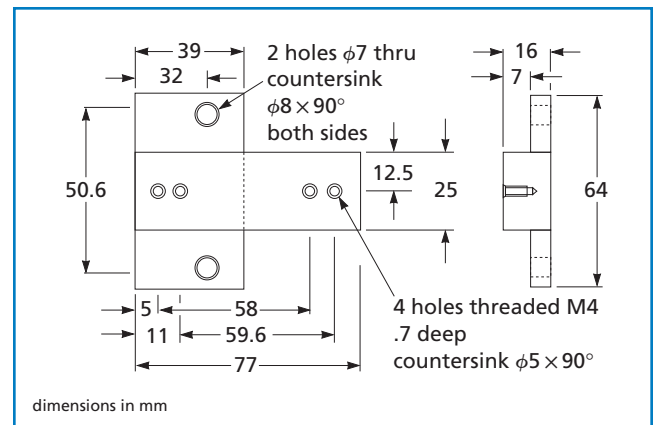
C-Mount Camera Adaptor

	PART NUMBER
C-Mount Camera Adaptor	07 ACM 001



Microscope Mounting Plate

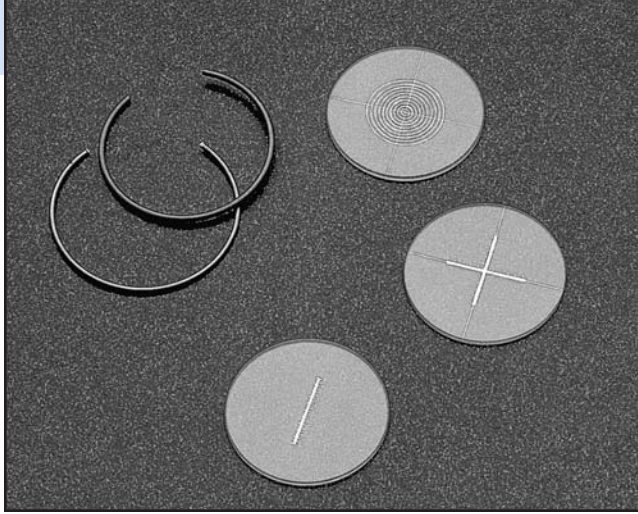
- Designed for use with focusing microscope bodies and focusing stages.
- This plate allows a microscope to be mounted with either 1/4-20 screws on 1-inch centers or M6 screws on 25-mm centers.
- The plate is provided with four M4 screws for mounting to microscope bodies.



07 HMB 001 microscope mounting plate

Microscope Mounting Plate

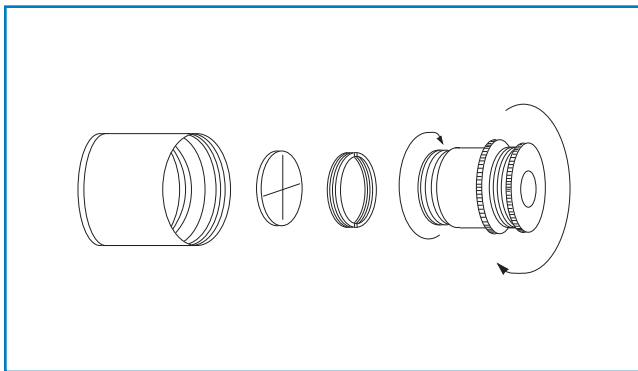
	PART NUMBER
Microscope Mounting Plate	07 HMB 001



CVI Melles Griot reticles are precision photochrome reproductions on a polished BK7 glass plate. Since the focal plane of the Huygens (negative) eyepiece is located between its lenses, the eyepiece must be disassembled to mount a reticle. Not all Huygens eyepieces can accept a reticle. A spring-wire retaining ring is available for mounting these reticles into non-CVI Melles Griot eyepieces.

SPECIFICATIONS: Reticles

Material	BK7
Diameter Tolerance	+ 0/− 0.05 mm
Thickness	1.0 ± 0.1 mm
Line Width	10 μm



Reticle installation for Huygens eyepiece

Reticles

Type	Diameter (mm)	PART NUMBER
Crosshair pattern		
	21	04 RET 001
	19	04 RET 002
Crosshair with 10 concentric circles, outside circle 10 mm φ		
	21	04 RET 003
	19	04 RET 004
10-mm Scale (100 Div)		
	21	04 RET 005
5-mm Scale (100 Div)		
	21	04 RET 007
Crosshair, 10-mm Scale (100 Div)		
	21	04 RET 011
	19	04 RET 012
Crossed 10-mm Scales (100 Div)		
	21	04 RET 013
	19	04 RET 014

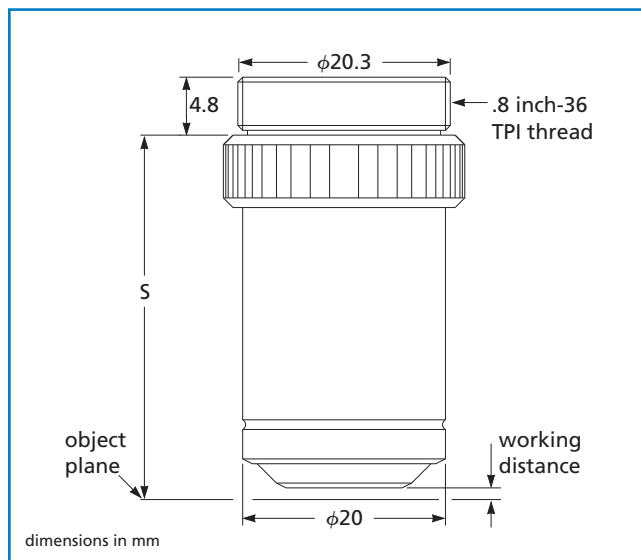
Reticle Retaining Ring for Non-CVI Melles Griot Eyepieces

Type	Diameter (mm)	PART NUMBER
Retaining Ring	23	04 SWR 021



The visible, infrared, flat-field and laser microscope objectives from CVI Melles Griot are achromatic (i.e., color corrected at 656.3 nm and 486.1 nm). The RMS mounting thread (0.8 inch, 36 TPI) matches the industry standard making these objectives compatible with non-CVI Melles Griot microscopes. Color coding makes identifying objective power easy when numerical markings cannot be seen. The UV microscope objectives with their air-spaced doublet or triplet designs are perfect for micromachining, laser-scribing and microlithography.

- The tolerance on power is $\pm 5\%$.
- The housing, made of brass, has a black finish on all surfaces.
- All objectives are antireflection coated. The visible objectives are coated for 400 to 700 nm; the infrared objectives are coated for 1300 to 1500 nm.



04 OAS microscope objectives

Microscope Objectives

Standard Microscope Objectives

- Objectives are color corrected for visual inspection and viewing.
- They are ideal for black-and-white microphotography.
- Objectives with magnification of $25\times$ and $40\times$ have a spring-loaded (retractable) front end to prevent damage to both the lens and the object in the event of contact during focusing.
- Standard objectives can be used to focus laser beams and to construct spatial filters and beam expanders.
- The mechanical tube length is 160 mm (the distance from the mounting shoulder of the objective to the image plane is 150 mm).

Standard Visible Microscope Objectives

Power	NA	Working Distance (mm)	Focal Length (mm)	S (mm)	Ring Color	PART NUMBER
1.0 ×	0.05	120.00	73.5	144	Black	04 OAS 002
2.5 ×	0.07	42.00	43.1	66	Brown	04 OAS 004
4.0 ×	0.12	24.00	30.8	45	Red	04 OAS 006
6.3 ×	0.20	21.00	22.5	45	Orange	04 OAS 008
10.0 ×	0.25	6.80	16.9	45	Yellow	04 OAS 010
16.0 ×	0.32	3.70	10.8	45	Lt Green	04 OAS 012
25.0 ×	0.50	1.30	6.6	45	Dk Green	04 OAS 014
40.0 ×	0.65	0.47	4.6	45	Lt Blue	04 OAS 016

Standard Infrared Microscope Objectives

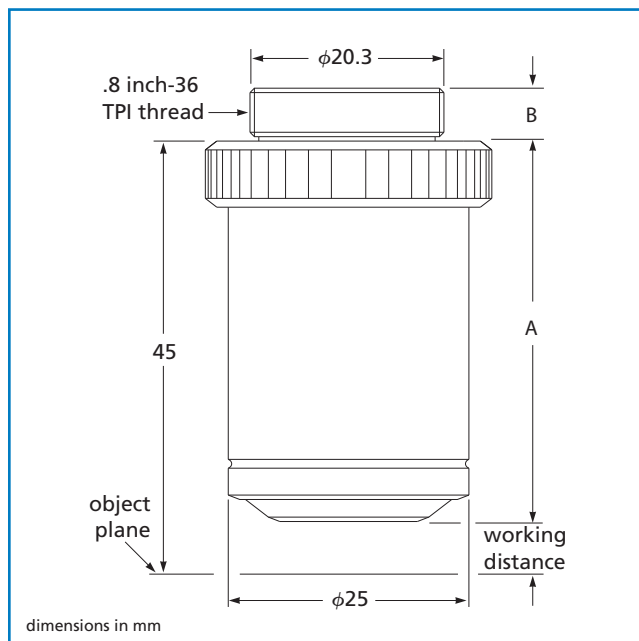
Power	NA	Working Distance (mm)	Focal Length (mm)	S (mm)	Ring Color	PART NUMBER
10.0 ×	0.25	6.80	16.9	45	Yellow	04 OAS 010/IR
25.0 ×	0.50	1.30	6.6	45	Dk Green	04 OAS 014/IR
40.0 ×	0.65	0.47	4.6	45	Lt Blue	04 OAS 016/IR

Note: Focal length measured at 632.8 nm.



Infinite-Conjugate Flat-Field Microscope Objectives

- Objectives are corrected to show little or no field curvature over the useful field.
- Flat-field objectives are ideal for microphotography and laser focusing applications where the laser spot needs to be scanned over the field of view.
- To obtain the indicated magnification, these objectives should be used in conjunction with a 180-mm focal length tube lens (e.g., our LAO-180.0-30.0 precision optimized achromat).



O4 OAI microscope objective

Infinite-Conjugate Flat-Field Microscope Objectives

Power	NA	Working Distance (mm)	Focal Length (mm)	Ring Color	PART NUMBER
4.0 ×	0.1	7.13	45.72	Red	04 OAI 001
10.0 ×	0.25	4.7	18.23	Yellow	04 OAI 003
40.0 ×	0.65	0.72	4.48	Lt Blue	04 OAI 005

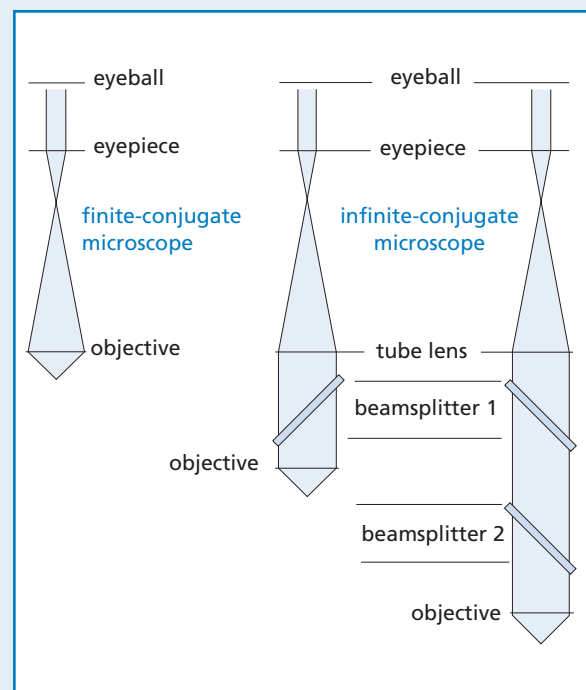
APPLICATION NOTE

Finite-Conjugate Microscope

The distance between the objective and the eyepiece is fixed, as this determines the magnification. Furthermore, since the light rays are converging in this region, any additional components will require adjusting the distance to keep the magnification constant, and will most likely introduce additional aberrations.

Infinite-Conjugate Microscope

Light between the objective and the tube lens is collimated, allowing the distance between them to be varied without changing the magnification. Additional beamsplitters and filters can be inserted without introducing additional aberrations. Infinite-conjugate objectives are better suited to focusing collimated laser beams since a collimated laser is essentially a point source at infinity.





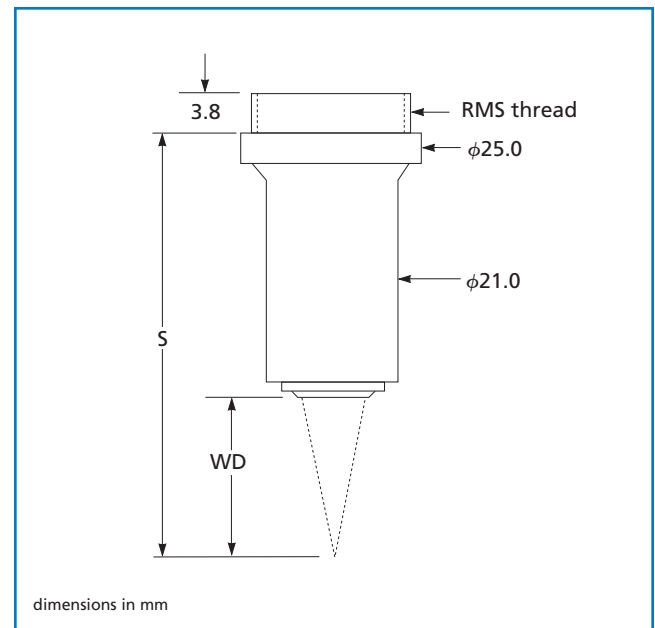
Laser Microscope Objectives

Infinite-Conjugate Visible and Near-IR Objectives

- These objectives are designed to transmit and focus high-power Nd:YAG laser beams.
- They provide diffraction-limited performance at 1064 nm.

SPECIFICATIONS: Infinite-Conjugate Visible and Near-IR Objectives

Optical Material	Fused silica
Damage Threshold (cw)	500 W/cm ²
Energy Throughput	>96% within design spectrum
Coating	Damage-resistant multilayer antireflection coating /A: Coating optimized for 532 nm /B: Coating optimized for 1064 nm Simply append appropriate coating suffix to part number



04 OAH-series objective lenses

Infinite-Conjugate Visible and Near-IR Objectives

Power	WD (mm)	Effective Focal Length (mm)	Numerical Aperture	Focused Spot Size* (μm)	Aperture (mm)	S (mm)	PART NUMBER
5 ×	35.0	40.0	0.13	12.0	10.0	58.9	04 OAH 001
10 ×	15.0	20.0	0.25	6.0	10.0	38.9	04 OAH 003
20 ×	6.0	10.0	0.40	4.0	8.0	39.8	04 OAH 005

*Calculated for 1064-nm input beam with Gaussian beam profile filling the aperture at the $1/e^2$ limits.

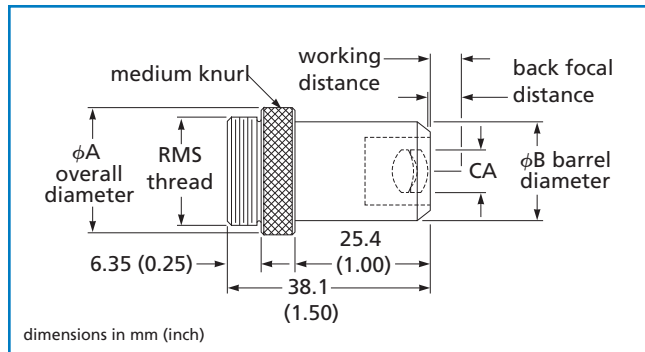


Infinite Conjugate UV Objective Lenses

A high damage threshold makes these UV objective lenses ideal for micro-machining applications. We offer these lenses in a black-anodized aluminum barrel or in the convenience of a microscope objective style housing. The housing has standard Royal Microscope Society (RMS) screw threads (0.8 × 36 TPI).

For a higher damage threshold, it is recommended to use a narrowband antireflection coating (V-coat). Call CVI Melles Griot for pricing and delivery.

- Perfect for micromachining, laser scribing, and microlithography
- Air-spaced doublet or triplet design for maximum UV transmission
- Infinite conjugate ratio design



UVO-series infinite conjugate objective lens for UV light

SPECIFICATIONS: Infinite Conjugate UV Objective Lenses

Antireflection Coating	User specified, $R_{avg} < 0.5\%$ per surface
Damage Threshold	500 mJ/cm ² , 20 nsec, 20 Hz @ 355 nm
Transmitted Wavefront Distortion	$3\lambda/4$ over 85% of clear aperture at 633 nm
Optical Material	UV-grade fused silica
Design Wavelength	355 nm
Housing	Black-anodized barrel mounted in a stainless steel microscope objective-style holder
Tube Lens Focal Length	170 mm

Infinite Conjugate UV Objective Lenses

Focal Length (mm)	f/#	Numerical Aperture	Power	Back Focal Length (mm)	Working Distance (mm)	Clear Aperture (mm)	Coating Range (nm)	φA (mm)	φB (mm)	PART NUMBER
4.0	5.3	0.09	42.5 ×	2.0	1.6	0.75	193–248	23.88	18.54	UVO-4.0-0.75-193-248
10.3	3.2	0.15	16.5 ×	6.3	5.9	3.2	193–248	23.88	18.54	UVO-10.3-3.2-193-248
14.0	4.7	0.11	12.1 ×	7.8	6.5	3.0	193–248	23.88	18.54	UVO-14.0-3.0-193-248
20.0	2.1	0.23	8.0 ×	14.8	13.0	10.0	193–248	28.58	23.88	UVO-20.0-10.0-193-248
4.0	5.3	0.09	42.5 ×	2.0	1.6	0.75	248–355	23.88	18.54	UVO-4.0-0.75-248-355
10.3	3.2	0.15	16.5 ×	6.3	5.9	3.2	248–355	23.88	18.54	UVO-10.3-3.2-248-355
14.0	4.7	0.11	12.1 ×	7.8	6.5	3.0	248–355	23.88	18.54	UVO-14.0-3.0-248-355
20.0	2.1	0.23	8.0 ×	14.8	13.0	10.0	248–355	28.58	23.88	UVO-20.0-10.0-248-355
4.0	5.3	0.09	42.5 ×	2.0	1.6	0.75	355–532	23.88	18.54	UVO-4.0-0.75-355-532
10.3	3.2	0.15	16.5 ×	6.3	5.9	3.2	355–532	23.88	18.54	UVO-10.3-3.2-355-532
14.0	4.7	0.11	12.1 ×	7.8	6.5	3.0	355–532	23.88	18.54	UVO-14.0-3.0-355-532
20.0	2.1	0.23	8.0 ×	14.8	13.0	10.0	355–532	28.58	23.88	UVO-20.0-10.0-355-532

Microscope Objectives

TYPES OF OBJECTIVES

Objectives are classified into groups depending on how well they are corrected for the dominant aberrations: chromatic aberration (color), spherical aberration, and field curvature. The simplest objectives (achromats) are corrected for color in the red and blue and for spherical aberration in the green. More complex objectives (apochromats) are color corrected in the red, yellow, and blue and corrected for spherical aberration at two to three different wavelengths. For applications that require good image quality across a wide FOV, "plan" objectives (plan achromats and plan apochromats) are also corrected for field curvature. Plan objectives generally have longer working distances than simple designs.

Each objective is designed to be used with a specific type of microscope. Biological objectives are corrected to view the object through a glass coverslip. If a biological objective, particularly one with a large NA, is used without a coverslip, the image will not be sharp. Similarly, non-biological objectives will not function optimally if there is glass between the objective and the object.

Older microscope objectives (before 1980) were designed to form an image at a given distance (the tube length) behind the objective flange. This distance varied between 160 mm and 210 mm depending on the manufacturer and the application. At the proper tube length, the objectives formed images at their nominal magnifications. Modern microscope objects are "infinity corrected." They are optimized to provide collimated light on their image side. A separate decollimating or tube lens then forms the image. This design gives microscope manufacturers flexibility to insert lighting and beamsplitters in the collimated space behind the objective. The proper focal length tube lens is required to form an image at the objective nominal magnification.

Many special-purpose objectives are available. Some are color corrected for wavelengths in the infrared or ultraviolet regions. Low-fluorescence objectives are available for ultraviolet fluorescence applications. Strain-free objectives are used for applications where the polarization of the image light must be maintained.

CHOOSING AN OBJECTIVE

The most important parameter for choosing a microscope objective is its NA. The larger the NA, the higher the resolving power, which means that the objective can distinguish closely spaced features from each other. The NA is related to the magnification; a higher magnification objective usually has a larger NA. The objective provides its specified magnification when used in a microscope with the proper tube length, or with the proper decollimating lens. The objective can also be used at different magnifications; the specified magnification provides an approximate guide. Both NA and magnification are usually printed on the barrel of the objective. An objective with a larger NA gathers more light but provides a smaller DOF, shorter working distance, and higher cost than an objective with a smaller NA. Because these tradeoffs are crucial to the success of the application, the objective NA must be chosen carefully.

The FOV is the sensor size divided by the magnification. The magnification (and FOV) can be adjusted by changing tube length or the focal length of the decollimating lens. Using a magnification greatly different from the one printed on the objective generally results in a poorly optimized system.

Microscope objectives have a small working distance (WD), the distance from the tip of the objective barrel to the object. This is a problem in machine vision, where there are often fixtures that must fit between the objective and the object. For those applications, there are objectives with longer working distance, called LWD or ELWD lenses. These objectives are larger and more expensive than standard objectives.

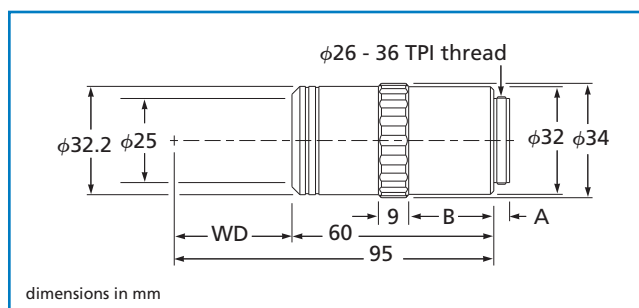
There are several different and incompatible standards for microscope mounting threads (DIN, JIS, RMS, and others). It is usually not possible to adapt from one thread to another. Within a single family, objectives are usually "parfocal", which means the distance from the objective mounting flange to the object is the same for each objective in the family. On a microscope, this means the the objective (and magnification) can be switched without a large refocus motion.



CVI Melles Griot long-working-distance plan apochromat objectives provide exceptional optical performance for near-ultraviolet, visible, and near-infrared wavelengths. Not only do these lenses provide a planar focus over the entire field of view, but each lens is color-corrected at four or more wavelengths throughout the specified spectral range at powers ranging from $2\times$ to $100\times$.

The 04 OVI-series lenses are designed for general applications in the visible spectral region. 04 ONU-series lenses can be used in both the near-ultraviolet and visible spectral regions, but they are optimized for micromachining applications using Nd:YAG lasers operating in the second and third harmonics (532 nm and 355 nm respectively). Likewise, the 04 ONI-series lenses are optimized for micromachining using the Nd:YAG fundamental (1064 nm) and second harmonic, but can be used for general purposes throughout the visible and near-infrared region.

- High resolution, small spot size
- Extra-long working distance
- Flat-field corrected for the entire field of view
- Free of chromatic aberration over the entire spectral range
- High transmittance
- Industry-standard thread



04 ONU-, 04 OVI-, and 04 ONI-series plan apochromats

SPECIFICATIONS:

Plan Apochromat Long-Working-Distance Objectives

Mounting Thread	RMS ($\phi 26$ mm, 36 TPI)
Parfocal Length	95 mm
Correction Wavelengths	
04 ONU Series	355, 486, 532, 588, and 656 nm
04 OVI Series	436, 486, 588, and 656 nm
04 ONI Series	486, 532, 588, 656, and 1064 nm
Transmittance¹	
04 ONU Series	60% (355 nm) 80% (436–656 nm)
04 OVI Series	80% (436–656 nm)
04 ONI Series	70% (436–656 nm, 1064 nm)
Damage Threshold²	
04 ONU Series	50 mJ/cm ² , 10-nsec pulse @ 355 nm 100 mJ/cm ² , 10-nsec pulse at 532 nm
04 OVI Series	Not specified
04 ONI Series	100 mJ/cm ² , 10-nsec pulse @ 532 nm 200 mJ/cm ² , 10-nsec pulse @ 1064 nm

¹ Average transmittance

² For reference only

Near-UV / Visible Plan Apochromat Lenses

Power	NA	WD (mm)	Focal Length (mm)	Resolution* (μm)	Depth of Focus* (μm)	Field of View (mm)			PART NUMBER
						ϕ 24-mm Eyepiece	A (mm)	B (mm)	
10 ×	0.28	35.0	20.0	1.0	3.5	0.88 × 0.66	4.7	25.3	04 ONU 010
20 ×	0.40	17.6	10.0	0.7	1.7	0.44 × 0.33	4.5	26.0	04 ONU 020
50 ×	0.42	15.3	4.0	0.7	1.6	0.18 × 0.13	4.7	25.3	04 ONU 050
100 ×	0.50	11.0	2.0	0.6	1.1	0.09 × 0.07	4.3	25.7	04 ONU 100

* Calculated at 550 nm

Visible Plan Apochromat Lenses

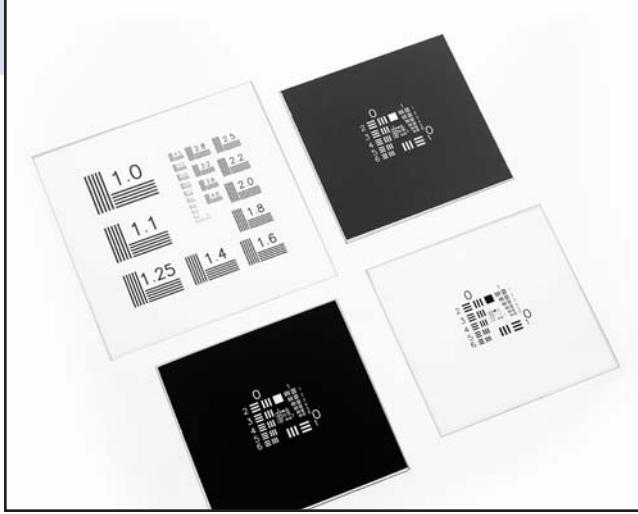
Power	NA	WD (mm)	Focal Length (mm)	Resolution* (μm)	Depth of Focus* (μm)	Field of View (mm)			PART NUMBER
						ϕ 24-mm Eyepiece	A (mm)	B (mm)	
2 ×	0.06	35.0	100.0	5.0	91.0	4.40 × 3.30	4.5	26.0	04 OVI 002
5 ×	0.14	35.0	40.0	2.0	14.0	1.80 × 1.30	4.7	25.3	04 OVI 005
10 ×	0.28	33.5	20.0	1.0	3.5	0.88 × 0.66	4.7	25.3	04 OVI 010
20 ×	0.42	20.0	10.0	0.7	1.6	0.44 × 0.33	4.7	25.3	04 OVI 020
50 ×	0.55	12.7	4.0	0.5	0.9	0.18 × 0.13	4.7	25.3	04 OVI 050
100 ×	0.70	6.0	2.0	0.4	0.6	0.09 × 0.07	4.7	25.3	04 OVI 100

* Calculated at 550 nm

Visible / Near-Infrared Plan Apochromat Lenses

Power	NA	WD (mm)	Focal Length (mm)	Resolution* (μm)	Depth of Focus* (μm)	Field of View (mm)			PART NUMBER
						ϕ 24-mm Eyepiece	A (mm)	B (mm)	
5 ×	0.14	35.0	40.0	2.0	14.0	1.76 × 1.32	4.7	26.0	04 ONI 005
10 ×	0.28	34.0	20.0	1.0	3.5	0.88 × 0.66	4.7	25.3	04 ONI 010
20 ×	0.40	20.0	10.0	0.7	1.7	0.44 × 0.33	4.3	25.7	04 ONI 020
50 ×	0.42	16.0	4.0	0.7	1.6	0.18 × 0.13	4.3	25.7	04 ONI 050

* Calculated at 550 nm



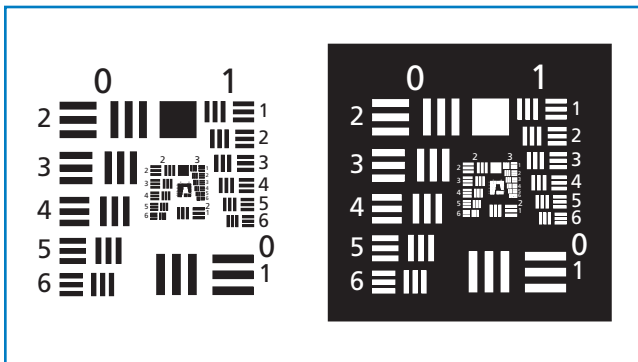
Resolution Test Targets

These test targets were designed to evaluate the performance of optical systems and photographic processes by assigning a numerical tolerance to the performance. The resolution of the system is determined by clearly identifying the smallest element (two target patterns of three lines each, at right angles to each other).

- The NBS 1963A test target indicates the number of the line pairs per millimeter for that element.
- The USAF test targets require the use of the table to identify the numbers of line pairs per millimeter for an element.

SPECIFICATIONS: Resolution Test Targets

Substrate	USAF: 50 × 50 × 1.5 mm NBS: 63.5 × 63.5 × 1.5 mm
Type	Evaporated chromium on soda-lime glass
Pattern	USAF 1951 or NBS 1963A
Range	USAF Chromium: 228 line pairs/mm NBS Chromium: 18 line pairs/mm

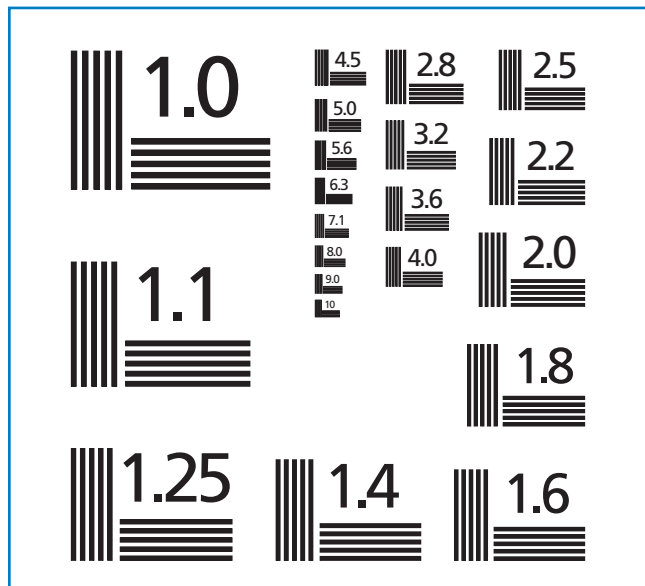


USAF test target

Line Pairs per Millimeter

Element Number	GROUP NUMBER							7*
	0	1	2	3	4	5	6	
1	1.00	2.00	4.00	8.00	16.0	32.0	64.0	128
2	1.12	2.24	4.49	8.98	17.95	36.0	71.8	144
3	1.26	2.52	5.04	10.10	20.16	40.3	80.6	161
4	1.41	2.83	5.66	11.30	22.62	45.3	90.5	181
5	1.59	3.17	6.35	12.70	25.39	50.8	102.0	203
6	1.78	3.56	7.13	14.30	28.51	57.0	114.0	228

*Chromium only



NBS test target

Resolution Test Targets

	PART NUMBER
USAF 1951 Chromium Positive	04 TRP 003
USAF 1951 Chromium Negative	04 TRN 003
NBS 1963A Chromium Positive	04 TRP 005

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