

# Microscope Units

Microscope units, objectives, eyepieces and accessories

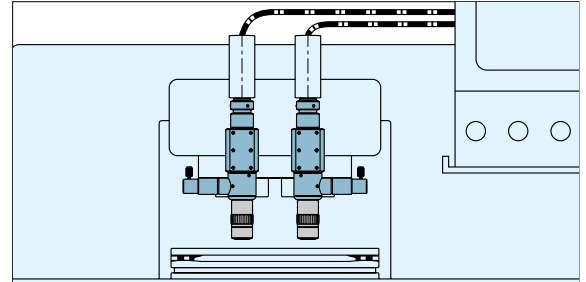


**Mitutoyo long working distance objective  
for various observation demands.**

The ultra-microscopic manufacturing technologies in the industrial world today require accuracy in the units of sub-microns. Mitutoyo has been introducing a series of microscope units with various features, combining the optical technologies developed by us and the precision measurement technologies developed over a long period of time. Mitutoyo microscopes can be integrated into systems like a various manufacturing equipment, research and development equipment, and product inspection equipment. Contact your nearest Mitutoyo office for detail specifications not included in this catalog, as well as for design and production of microscopes that best fit your specifications.

## 1. Microscope unit for system integration VMU

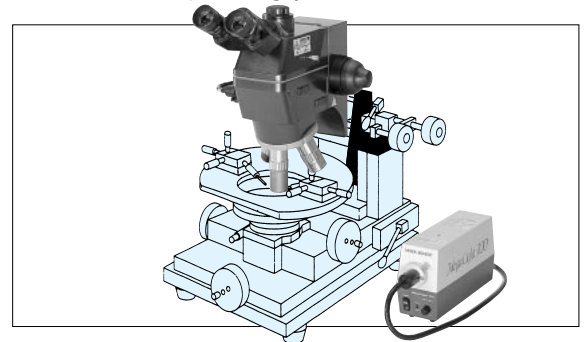
- Lightweight, small-size microscope unit for monitor system
- Used together with an image-processing device, it can perform dimensional measurement, contour inspection, positioning, etc.
- A new line of models for YAG Laser is now available, for cutting thin-films in semiconductors, liquid crystal substrates, and such.



Semiconductor-mask positioning system

## 2. High power microscope unit FS70

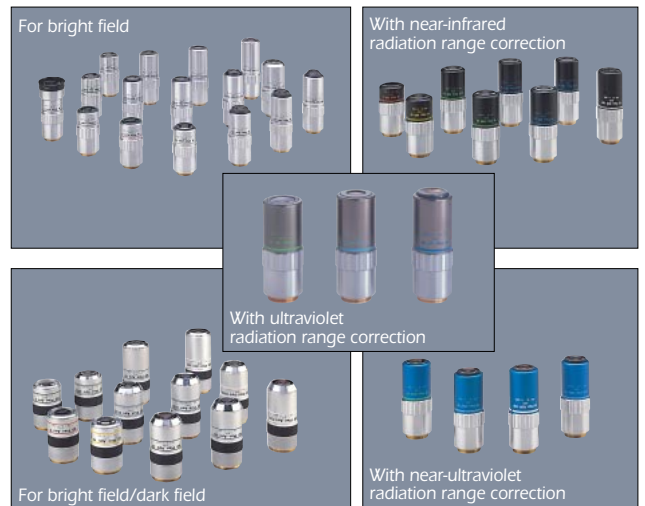
- The FS70 series can provide the erect image with a maximum magnification of 4,000x to facilitate operation. It is ideal for a prober station for semiconductors.
- In addition to the standard inward-revolver optional revolvers with the center-adjustment and parfocal mechanisms are available.
- For bright field, Differential Interference Contrast (DIC) and polarized observations. (The FS70L and FS70L4 do not support DIC observation.)
- The FS70L and FS70L4 can be equipped with YAG Laser to cut semiconductor circuits and repair liquid crystal substrates.



Analytical prober station for semiconductors

## 3. Long working distance objectives M Plan Apo

- A specimen with steps, which cannot be focused on with the conventional short working distance objectives, can be easily observed with the use of Mitutoyo long working distance objectives (e.g. 200x objective: 13mm).
- The M Plan Apo (Achromat) is an excellent optical system, with the flat and chromatic aberration free image over the entire field of view.
- Various objectives for a wide range of light wavelengths, from near-infrared to ultraviolet radiation, are available: the near-infrared radiation corrected objectives for laser-cutting applications; the near-ultraviolet radiation corrected objectives; and the glass-thickness compensation objectives that allow observation of a vacuum furnace interior through a glass, for example.



### Various observation methods

<p><b>■ Bright field</b></p> <p>A general observation method. A reflective light from the specimen is used for observation.</p>	<p><b>■ Dark field</b></p> <p>A effective observation method for observing scratches, dust, and uneven surfaces. This method is also used for specimens with a low reflective rate.</p>	<p><b>■ Differential Interference Contrast (DIC) method</b></p> <p>Since this method offers excellent depth detection, it is most ideal for observations of metal, crystal, semiconductor, etc. with ultra-small scratches, steps, and uneven surfaces.</p>	<p><b>■ Polarization</b></p> <p>This method is used to observe optical characteristics of minerals, plastics, and liquid crystals.</p>

# Contents

## VMU Video Microscope Unit

VMU-V: Vertical camera-mount type  
VMU-H: Horizontal camera-mount type  
VMU-L: With laser mount (near-infrared to near-ultraviolet)  
VMU-L4: With laser mount (ultraviolet)

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## FS70 Microscope Unit

FS70/FS70Z: With fiber illumination  
FS70L: Bright field with laser mount  
(near-infrared to near-ultraviolet)  
FS70L4: Bright field with laser mount (ultraviolet)

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## VM-ZOOM Zoom Video Microscope Unit

VMZ40M: Manual zooming  
VMZ40R: Power zooming  
VMZ40R-L4, BL4: Power zooming with ultraviolet  
radiation correction

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## Objectives for bright field

M Plan Apo:	Long working distance	P.11
M Plan Apo LS:	Super-long working distance	P.12
M Plan Apo:	High-resolving power	P.13
G Plan Apo:	With glass-thickness compensation	P.13
M Plan NIR:	Near-infrared radiation corrected	P.14
LCD Plan NIR:	Liquid crystal thickness and near-infrared radiation corrected	P.14
M Plan NUV:	Near-ultraviolet radiation corrected	P.15
LCD Plan NUV:	Liquid crystal thickness and ultraviolet radiation corrected	P.15
M Plan UV:	Ultraviolet radiation corrected	P.16

## Objectives for bright field/dark field

BD Plan Apo:	Long working distance	P.17
BD Plan Apo SL:	Super-long working distance	P.18
BD Plan Apo:	High resolving power	P.18

## Objectives for finity correction system

Standard objectives	P.19
Compact objectives	P.20

## Eyepieces & Reticles

Wide field of view eyepieces

- WF10x/24: Magnification 10x, Field of view 24mm
- WF15x/16: Magnification 15x, Field of view 16mm
- WF20x/12: Magnification 20x, Field of view 12mm

Reticles P.20

## Optional accessories

### Illumination systems

Fiber illuminator  
Ring fiber illuminator

P.21

### Monitor system

Color CCD monitor system

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### TV camera adapter, Polarizer, Stand, DIC unit

TV camera adapter B for FS70  
0.5x TV camera adapter for FS70  
Stands for FS70, VMU and VM-ZOOM  
Polarizer (polarization unit) for FS70

Differential Interference Contrast (DIC) unit for FS70Z

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## References

### Placement of lenses

- Placement of objective and tube lens
- Placement of objective and tube lens for laser applications

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### Tube lenses

- MT-1
- MT-2
- MT-40
- MT-L
- MT-L4

P.23 to 24

### Optical characteristics of objectives

- Light-transmitting
- Caution in using YAG laser

P.25

### Mounting screw standards

- Objectives for bright field and objectives for finity correction system
- Objectives for bright field and dark field
- C-mount

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### Glossary

- Numerical Aperture
- Resolution
- Working distance
- Parfocal length
- Infinity correction system
- Finity correction system
- Focal length
- Real field of view
- Depth of focus
- Bright field illumination and dark field illumination
- Apochromat objective and achromatic objective

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### Optical systems of microscope units

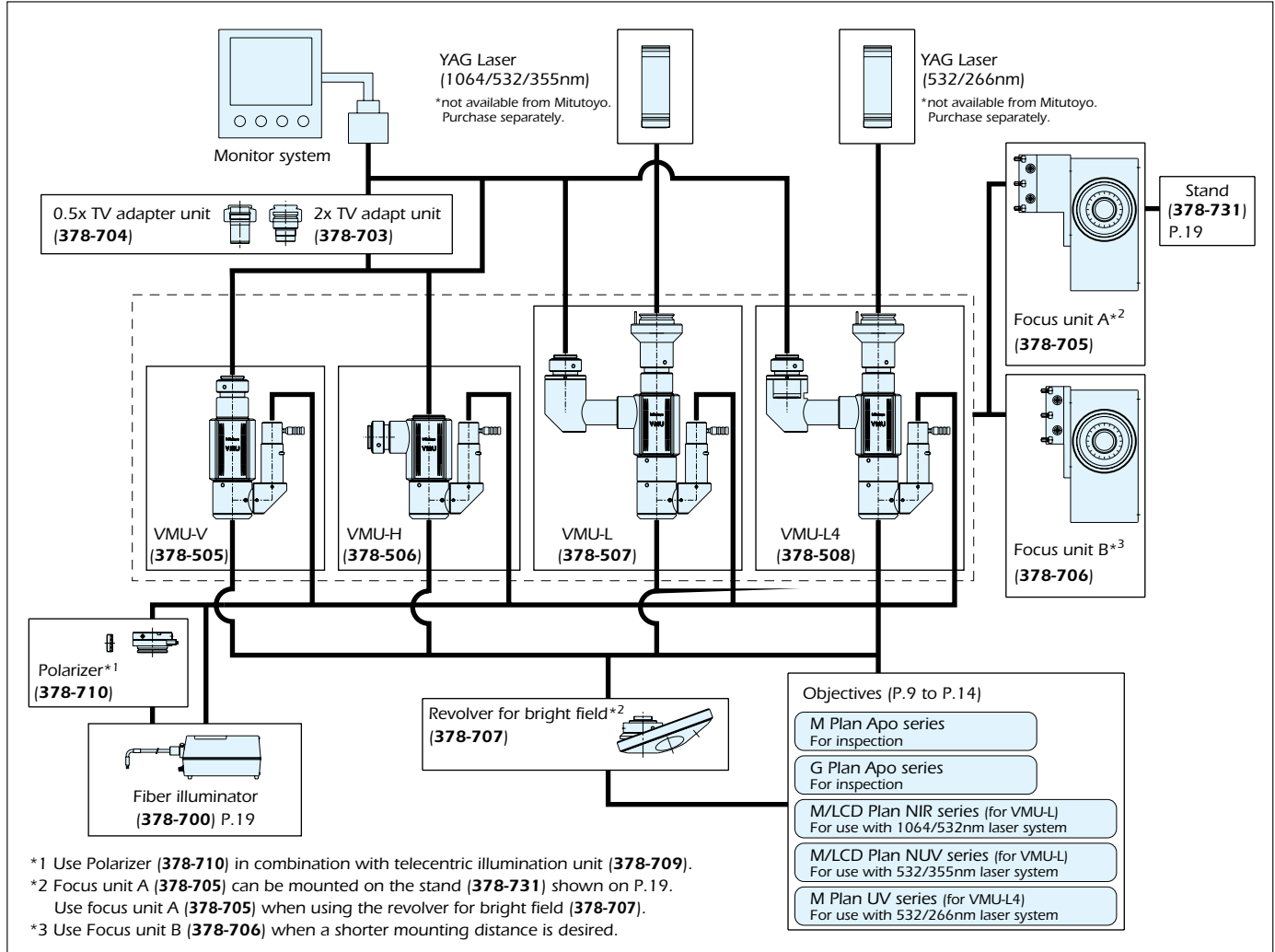
VMU-V, FS70Z

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## FEATURES

1. Small, lightweight microscope unit with a high performance-cost ratio. This unit is used as an integrated part of an inspection system.
2. For a wide range of laser applications, such as laser-cutting fine-films of semiconductors and of liquid crystal substrates. The optical systems of the VMU support ranges of laser wavelengths: the VMU-L supports standard waves (1064nm: near-infrared), Class 2 higher harmonics (532nm: visible) and Class 3 higher harmonics (355nm: near-ultraviolet) YAG lasers; the VMU-L4 supports Class 2 and Class 4 higher-harmonics YAG lasers;

## SYSTEM CONFIGURATION



## SPECIFICATIONS

Model No.	VMU-V	VMU-H	VMU-L <sup>1</sup>	VMU-L4 <sup>1</sup>
Order No.	378-505	378-506	378-507	378-508
Camera mount	Vertical	Horizontal	Vertical	
Observation image	BF/erect image	BF/inverted image	BF/erect image	BF/erect image
Optical tube	with C-mount & centering mechanism			
	Tube lens (correction)		with green filter switch	
	1x (near-infrared and visible radiation)		1x (near-infrared - visible - near-ultraviolet radiation)	1x (visible and ultraviolet radiation)
Applicable laser	—		1064/532/355nm YAG laser	532/266nm YAG laser
Objectives (optional)	M Plan Apo <sup>2</sup> , M Plan Apo SL, G Plan Apo			
	—		M/LCD Plan NIR <sup>3</sup> , M/LCD Plan NUV <sup>3</sup>	M Plan UV
Applicable camera	1/2 inch or smaller CCD camera (C-mount type)			
Illumination system	Telecentric reflective illumination (with aperture diaphragm)			
Mass	650g	750g	850g	870g

-1: When using the VMU-L or -L4 with a laser system, refer to "Cautions in using microscope with YAG laser system" on P.23.

-2: M Plan Apo 1x should be used together with the telecentric illumination unit (378-709) and the polarizer (378-710).

-3: Select model depending on the type of laser wavelength.

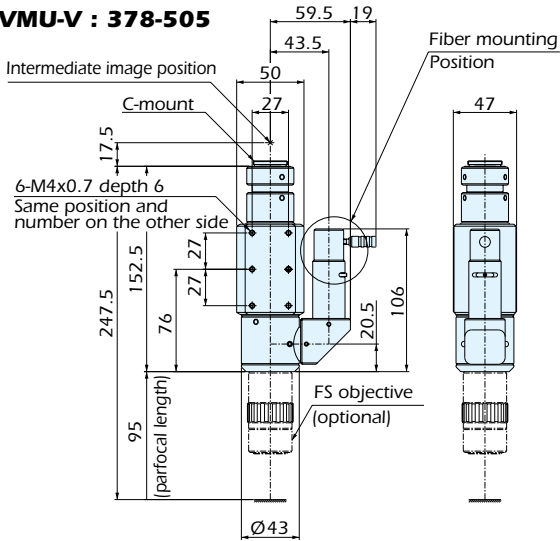
(266nm: ultraviolet) YAG lasers. However, Mitutoyo assumes no responsibility whatsoever for the performance and/or safety of the laser system used with Mitutoyo microscopes. A careful examination is recommended in selecting a laser emission unit.

3. Various optional accessories are available for various combinations:

Revolver for 4 objectives for bright field observation, C-mount adapter unit (0.5x/2x), Polarizer, etc. The Telecentric illumination unit with aperture diaphragm is ideal for a image processing that requires a depolarized illumination.

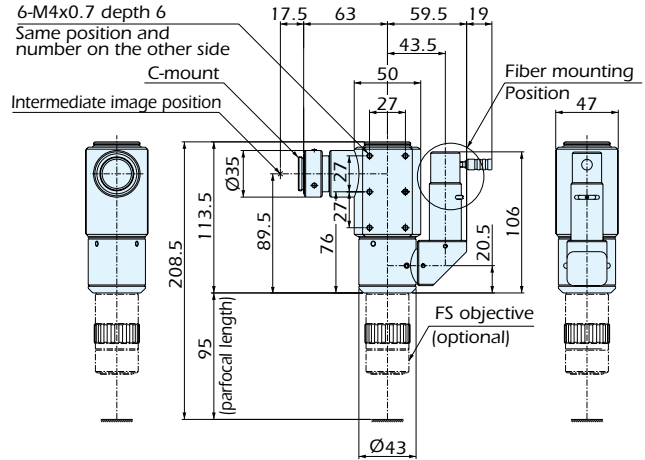
## DIMENSIONS

### VMU-V : 378-505

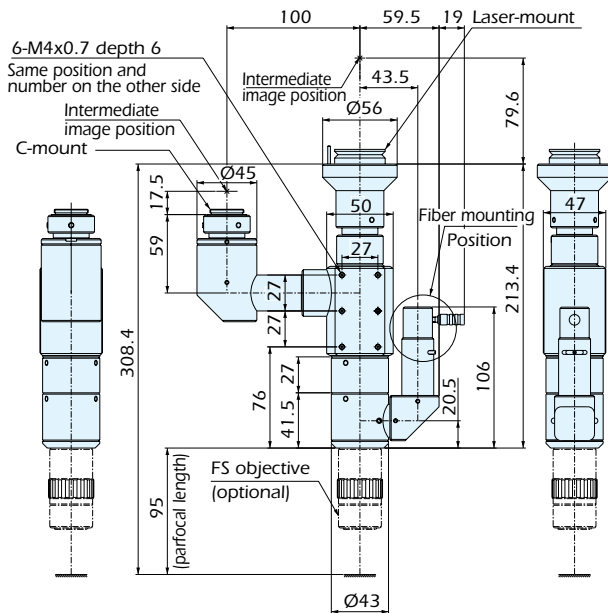


### VMU-H : 378-506

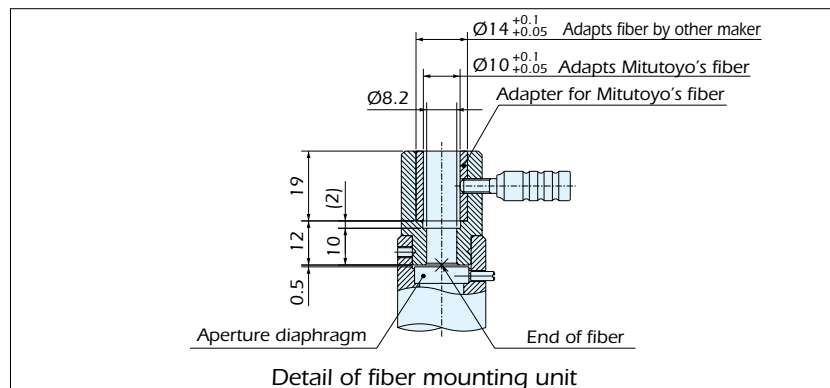
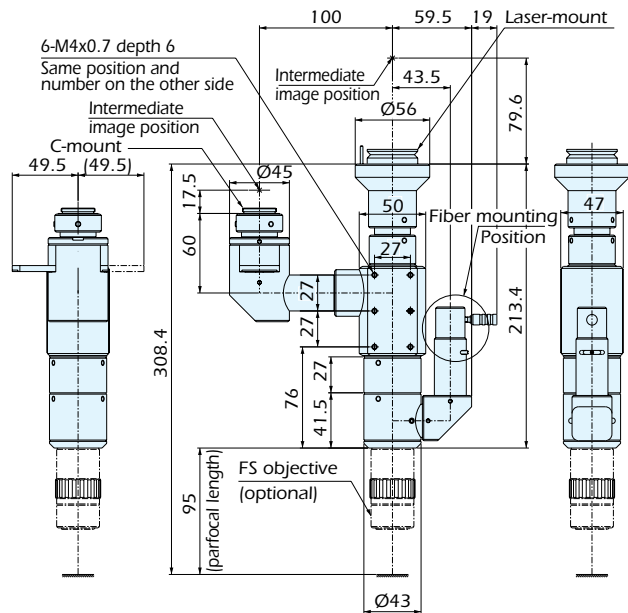
Unit: mm



### VMU-L : 378-507



### VMU-L4 : 378-508

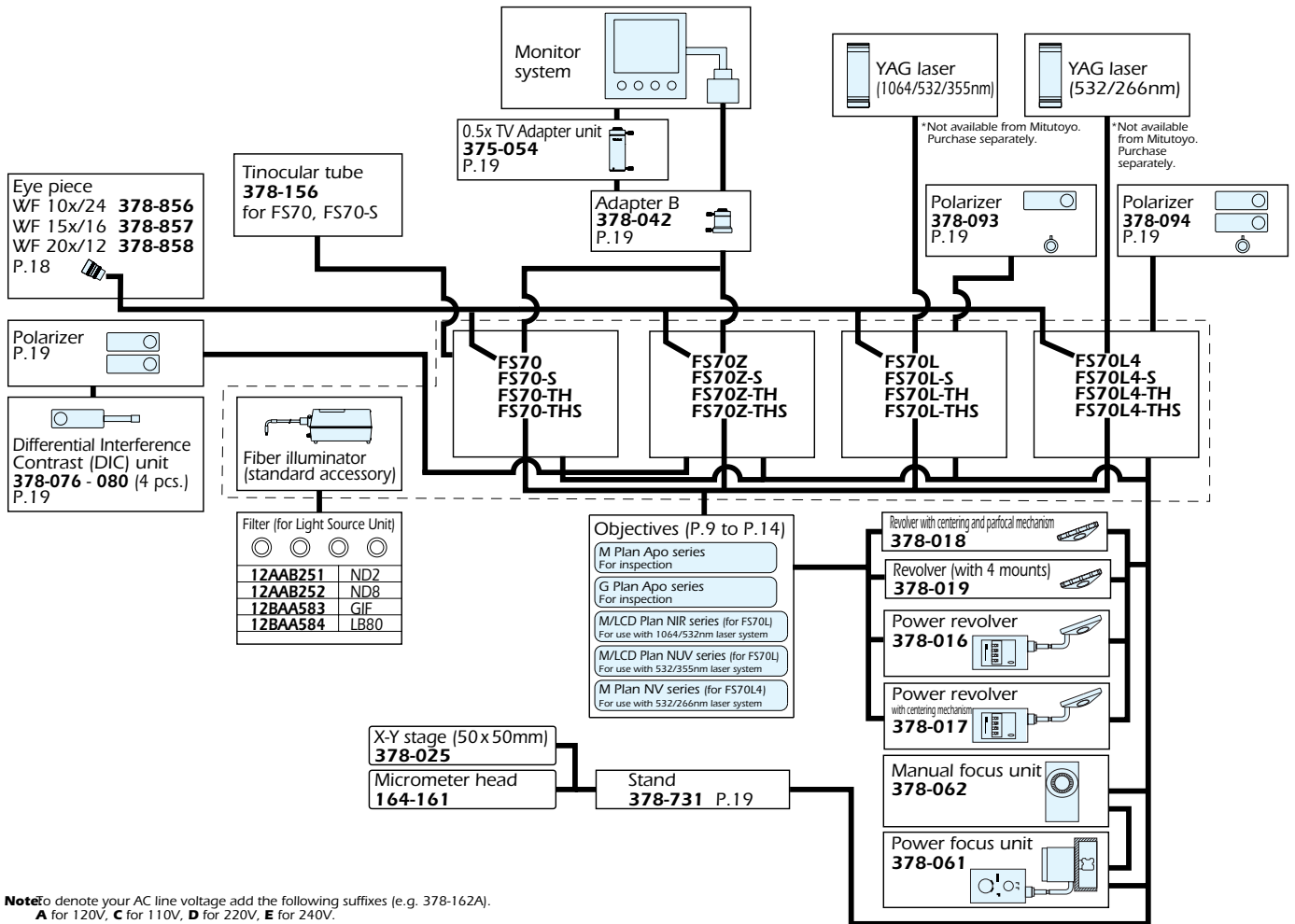


# FS70

## FEATURES

1. The optical system that was originally developed for the best seller FS60 models was further enhanced for the FS70 models. It is ideal as a microscope unit of a prober station for semiconductors. (All models CE marked.)
2. The FS70L supports three types of YAG laser wavelength ranges (1064nm, 532nm and 355nm), while the FS70L4 supports two types of wavelength ranges (532nm and 266nm), thus expanding a scope of laser applications, allowing laser-cutting of thin-films used in

## SYSTEM CONFIGURATION



Note: To denote your AC line voltage add the following suffixes (e.g. 378-162A).  
A for 120V, C for 110V, D for 220V, E for 240V.

## AVAILABLE MODELS

### Basic models

- FS70:**  
with standard base
- FS70-S:**  
with shrot base
- FS70-TH:**  
with tilting head and standard base
- FS70-THS:**  
with tilting head and short base

### 1x - 2x zoom models

- FS70Z:**  
with standard base
- FS70Z-S:**  
with shrot base
- FS70Z-TH:**  
with tilting head and standard base
- FS70Z-THS:**  
with tilting head and short base

### 1064nm/532nm/355nm laser models

- FS70L:**  
with standard base
- FS70L-S:**  
with shrot base
- FS70L-TH:**  
with tilting head and standard base
- FS70L-THS:**  
with tilting head and short base

### 532nm/266nm laser models

- FS70L4:**  
with standard base
- FS70L4-S:**  
with shrot base
- FS70L4-TH:**  
with tilting head and standard base
- FS70L4-THS:**  
with tilting head and short base

semiconductors and liquid crystal substrates. However, Mitutoyo assumes no responsibility whatsoever for the performance and/or safety of the laser system used with Mitutoyo microscopes. A careful examination is recommended in selecting a laser-emission unit.

- Bright field, Differential Interference Contrast (DIC) and polarized observations are standard with the FS70Z. The FS70L and FS70L4 do not support the DIC method.

## ■ SPECIFICATIONS

Model No.	FS70	FS70-TH	FS70Z	FS70Z-TH
Order No.	378-184-1	378-184-3	378-185-1	378-185-3
Model No.	FS70-S	FS70-THS	FS70Z-S	FS70Z-THS
Order No.	378-184-2	378-184-4	378-185-2	378-185-4
Focus adjustment	With concentric coarse and fine focusing wheels (right and left) (50mm travel range, 0.1mm/rev. for fine adjustment, 3.8mm/rev. for coarse adjustment)			
Trinocular tube Image	Erect image			
Pupil distance	Siedentopf type, adjustment range: 51 - 76mm			
Field number	24			
Tilt angle	0° - 20° (only -TH, -THS models)			
Optical pass ratio	50/50 <sup>1</sup>	100/0 or 0/100 <sup>2</sup>	50/50 <sup>1</sup>	100/0 or 0/100 <sup>2</sup>
Protective filter	—			
Main unit				
Tube lens	1x		1x -2x zoom	
Applicable YAG laser	1064/532/355nm (when using optional tube)		—	
Camera mount	Adapter B (C-mount) <sup>3</sup>			
Illumination system	Reflective illumination for bright field (Koehler illumination, with aperture diaphragm)			
Light source	12V100W fiber optics, (non-stepped adjustment), light guide length 1.5m, power consumption 150W			
Objectives <sup>3</sup>				
For observation	M Plan Apo <sup>4</sup> , M Plan Apo SL, G Plan Apo			
For laser-cutting	—			
Loading weight on optical tube <sup>6</sup>	14.5kg	13.6kg	14.1kg	13.2kg
Mass (main unit)	6.1kg	7.1kg	6.6kg	7.5kg

When using the FS70L or -L4 with a laser system, refer to "Cautions in using microscope with YAG laser system" on P.23.

-1: Eyepiece/CCD camera

-2: Eyepiece/laser

-3: Optional

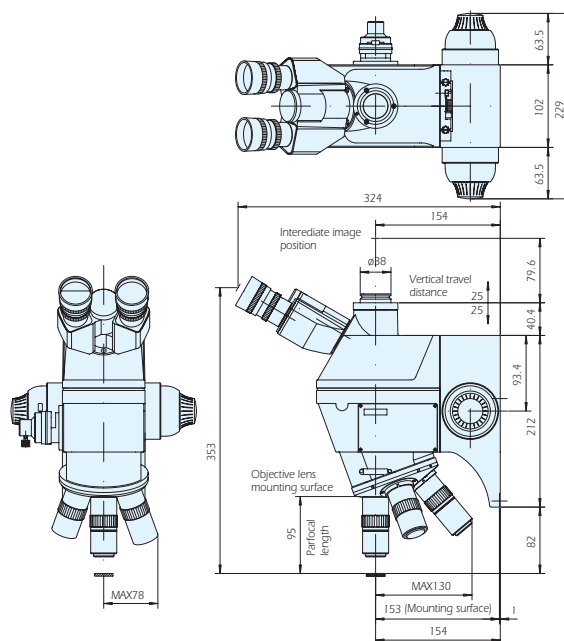
-4: M Plan Apo 1x should be used together with the the polarizer (378-092).

-5: Select model depending on the type of laser wavelength.

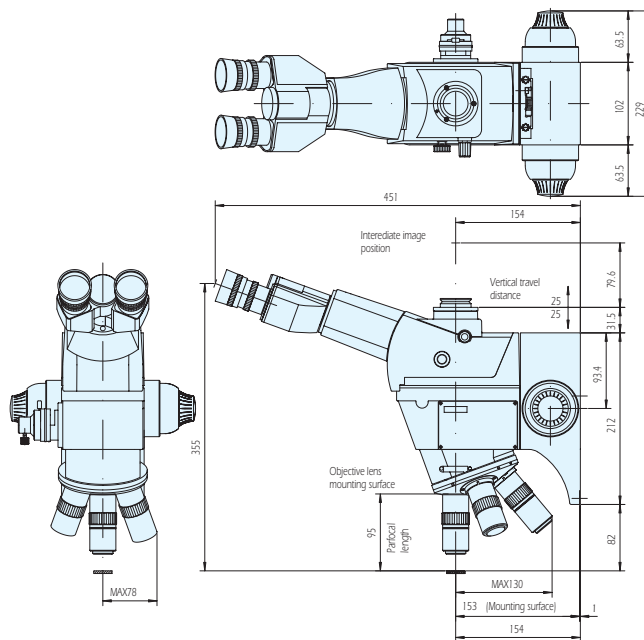
-6: Weight of objective lenses and eyepieces not included.

## ■ DIMENSIONS

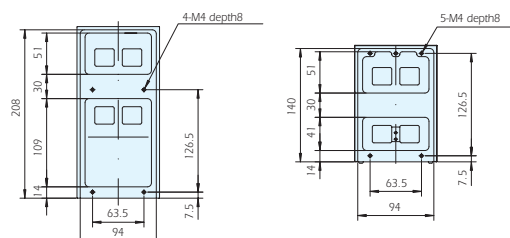
### FS70XX



### FS70XX-TH



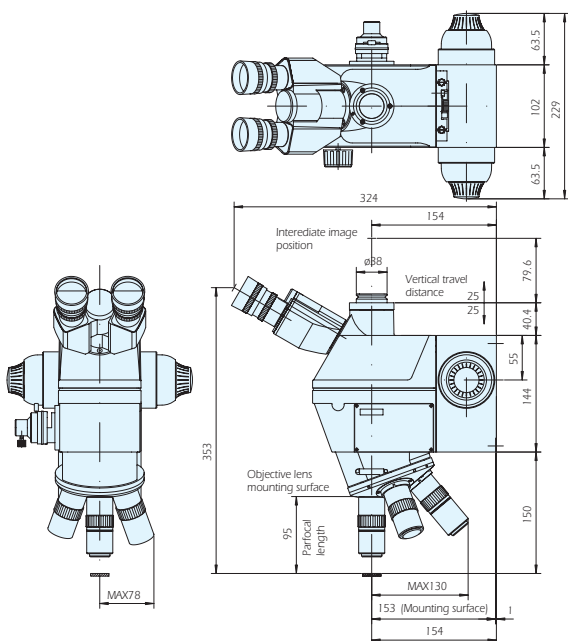
### Mounting-screw hole positions on the base (for all models)



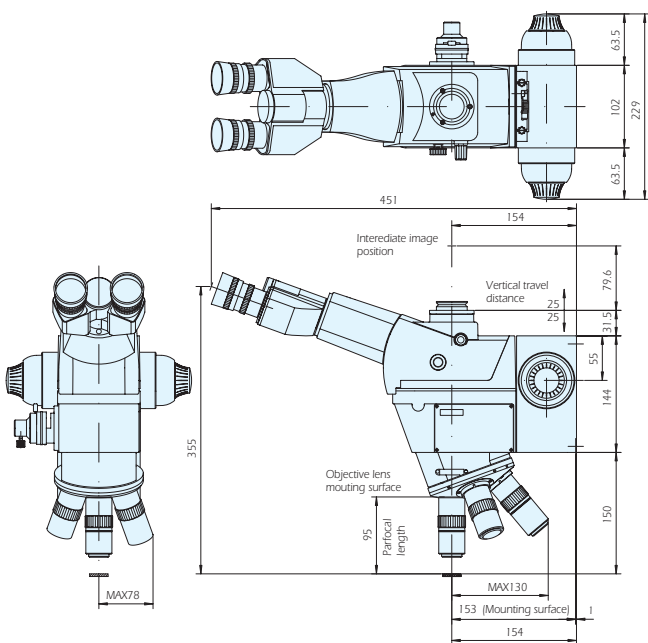
(For FSXXXX-S and FSXXXX-THS type)

## FS70XX-S

Unit: mm



## FS70XX-THS





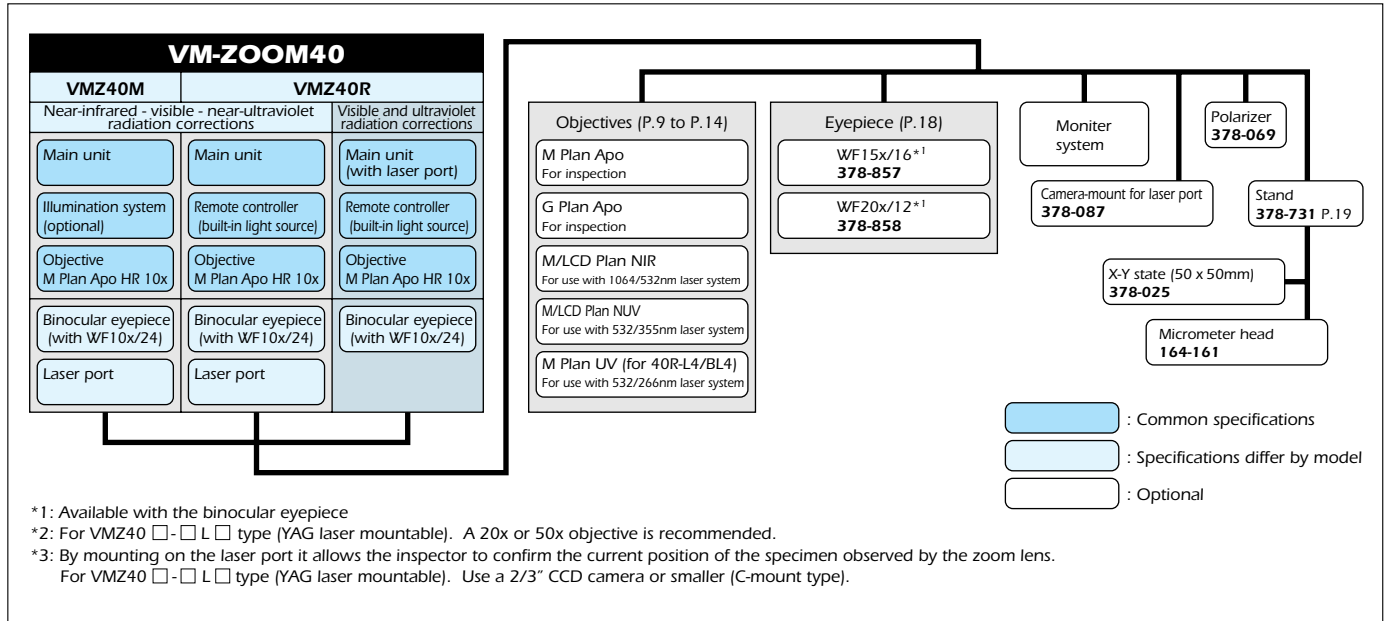
4. By employing an inward revolver, the long working distance objectives provide excellent operatability.
5. An ergonomic design with superb operatability: the FS70 employs the erect-image optical system (the image in the field of view has the same orientation as the specimen) and enlarged fine focus adjustment wheel with rubber grip coarse adjustment knob.

<b>FS70L</b> 378-186-1	<b>FS70L-TH</b> 378-186-3	<b>FS70L4</b> 378-187-1	<b>FS70L4-TH</b> 378-187-3
<b>FS70L-S</b> 378-186-2	<b>FS70L-THS</b> 378-186-4	<b>FS70L4-S</b> 378-187-2	<b>FS70L4-THS</b> 378-187-4
With concentric coarse and fine focusing wheels (right and left) (50mm travel range, 0.1mm/rev. for fine adjustment, 3.8mm/rev. for coarse adjustment)			
Erect image			
Siedentopf type, adjustment range: 51 - 76mm			
24			
0° - 20° (only -TH, -THS models)			
100/0 or 0/100 <sup>-2</sup>			
Built-in laser beam filter			
1x			
1064/532/355nm		1064/532/355nm	
— (use a laser with the TV port.)		C-mount receptacle (with green filter switch)	
Reflective illumination for bright field (Koehler illumination, with aperture diaphragm)			
12V100W fiber optics, (non-stepped adjustment), light guide length 1.5m, power consumption 150W			
M Plan Apo <sup>4</sup> , M Plan Apo SL, G Plan Apo			
M/LCD Plan NIR <sup>5</sup> , M/LCD Plan NUV <sup>5</sup>		M Plan UV	
14.5kg	13.6kg	14.1kg	13.2kg
6.1kg	7.1kg	6.6kg	7.5kg

# VM-ZOOM

1. The VM-ZOOM is a microscope unit with the high-zoom function. Like the FS70, it is ideal as an optical unit of a prober station for semiconductors.
2. Equipped with the built-in zoom lens with a magnification of 0.25x - 10x and the special high N.A. objective, the VM-Zoom offers a continuous image of 100 - 4000x on a 15" monitor.
3. There are a total of 10 models to choose from. Choose a model, combining it with the binocular eyepiece, the power zoom system, or YAG laser with a specific wavelength, depending on the specifications required for the purpose.

## SYSTEM CONFIGURATION



## SPECIFICATIONS

Note: To denote your AC line voltage add the following suffixes (e.g. 378-171A).  
**A** for 120V, **C** for 110V, **D** for 220V, **E** for 240V. **No suffix** is required for 100V

Model No.	VMZ40M	VMZ40M-L	VMZ40M-B	VMZ40M-BL	VMZ40R	VMZ40R-L	VMZ40R-B	VMZ40R-BL	VMZ40R-L4	VMZ40R-BL4
Order No.	378-171	378-173	378-172	378-174	378-175	378-177	378-176	378-178	378-181	378-182
Radiation range	Near-infrared - Visible - Near-ultraviolet								Visible and Ultraviolet	
Zoom type	Manual				Power drive					
Image	Bright field/erect image									
Main unit mag.	0.25x - 10x (Zoom ratio: 40)									
Total mag.	100x - 4000x (when using 10x objective, 1/2 inch CCD camera and 15" monitor)									
Observation range (when using 10x objective)	1/2 inch CCD camera: 2.56x1.92mm - 0.064x0.048mm Eyepiece (WF10x/24): Ø3.2mm - Ø0.08mm									
Eyepiece lens	—	10x, 15x, 20x			—	10x, 15x, 20x			—	10x, 15x, 20x
Objective <sup>1</sup> Observation	M Plan Apo, G Plan Apo									
Laser-cutting <sup>2</sup>	—	M/LCD Plan NIR	—	M/LCD Plan NIR	—	M/LCD Plan NIR	—	M/LCD Plan NIR	—	M Plan UV
	—	M/LCD Plan NUV	—	M/LCD Plan NUV	—	M/LCD Plan NUV	—	M/LCD Plan NUV	—	
Focus adjustment	With concentric coarse and fine focusing wheels (right and left) (50mm travel range, 0.1mm/rev. for fine adjustment, 3.8mm/rev. for coarse adjustment)									
Illumination system	Optional				Built-in remote controller with Auto-brightness control (2m light guide, 21V, 150W Halogen bulb <b>(215390)</b> bulb life 200H)					
Revolver	for BF lens (1 mount)	for BF lens (2 mounts) with centering mechanism			for BF lens (1 mount)	for BF lens (2 mounts) with centering mechanism				
TV adapter	with C-mount & centering mechanism								with green filter switch	
Camera	1/2 inch or smaller CCD camera (C-mount type)									
Power consumption	—				200W					
Mass (main unit)	6.5kg	7.0kg	7.5kg	8.0kg	7.0kg	7.5kg	8.0kg	8.5kg	7.5kg	8.5kg

\* When using the VM-ZOOM with a laser system, refer to "Cautions in using microscope with YAG laser system" on P.23.

-1: When using an objective other than the one that is a standard accessory, there may be times when the observation image of the specimen is not bright enough, depending on what type of specimen. A magnification of 2x - 50x is recommended.

-2: Select model depending on the type of laser wavelength.

4. Equipped with a unique sliding revolver, to which an additional NIR/NUV/UV objective, as well as the 10x standard objective can be attached, for processing thin-films in semiconductors and liquid crystal substrates. However, Mitutoyo assumes no responsibility whatsoever for the performance and/or safety of the laser system

used with Mitutoyo microscopes. A careful examination is recommended in selecting a laser system.

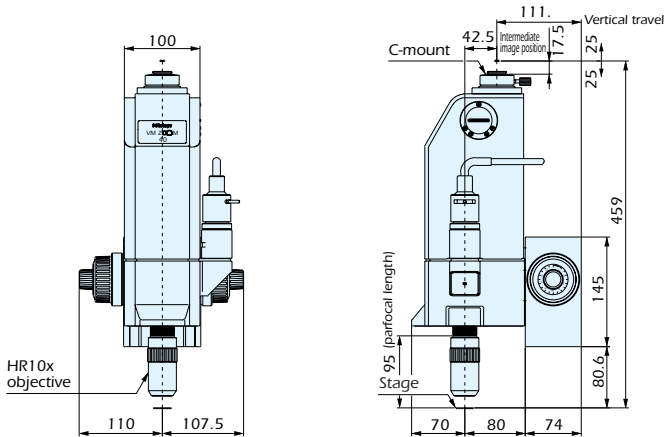
5. Customized specifications, such as polarization and Differential Interference Contrast observations, and a guaranteed magnification system (for power zoom type only) are also available.

# VMZ40

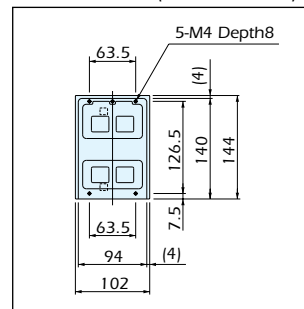
- R** : Power zoom
- M** : Manual zoom
- B** : With binocular eyepiece
- L** : YAG laser system (1064/532/355nm) can be attached
- L4** : YAG laser system (532/266nm) can be attached

## DIMENSIONS

**VMZ40M : 378-171**

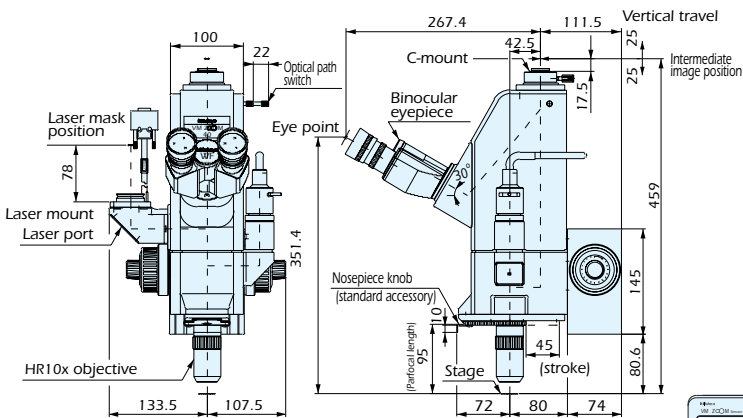


Mounting-screw hole positions on main unit (for all models)

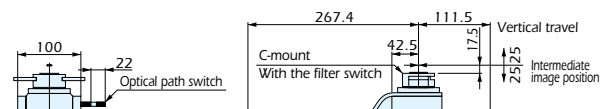


Unit: mm

**VMZ40R-BL : 378-178**

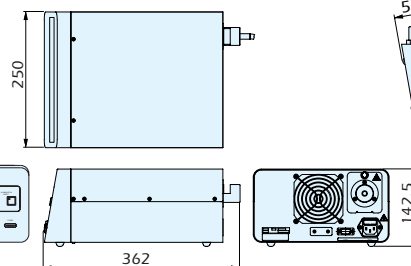


**VMZ40R-BL4 : 378-182 (shown only the TV-mount section)\***



\*VMZ40R-BL4 has the same specifications as the VMZ40R-BL, except for the specifications of the TV-mount section.

### Remote controller



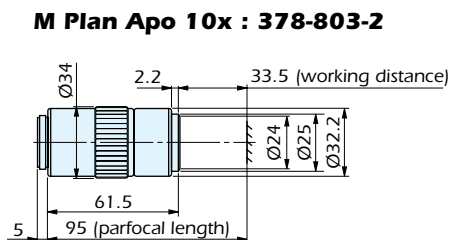
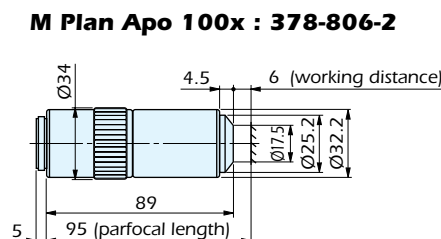
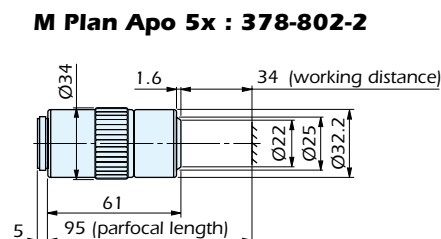
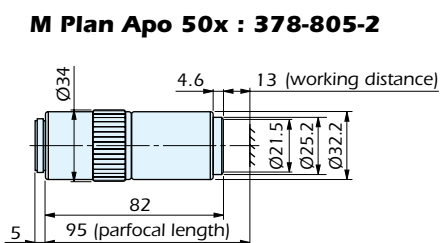
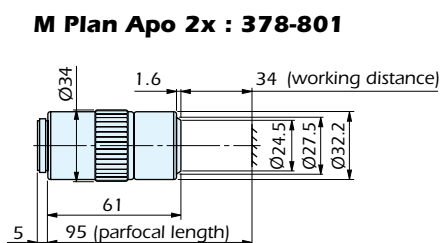
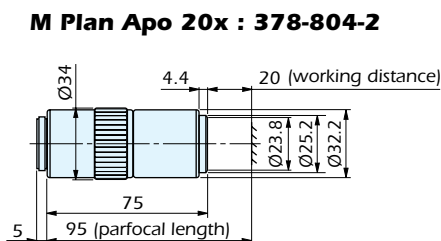
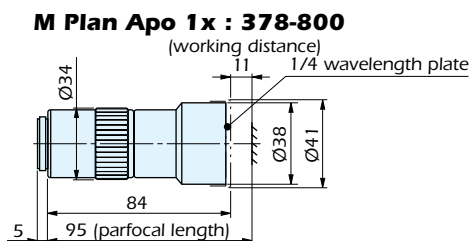
Weight: Approx. 7kg  
(Remote controller and jog-shuttle dial combined)

# M Plan Apo

1. A specimen with steps, which cannot be focused on with the conventional short working distance objectives, can be easily observed with the use of Mitutoyo long working distance objectives (M Plan Apo 100x: 6mm).
2. The M Plan Apo (Apochromat) is an excellent optical system, with the flat and chromatic aberration free image over the entire field of view.

■ DIMENSIONS

\*Mounting screws 26, thread 36 (see P.24.)



Unit: mm

■ SPECIFICATIONS

Order No.	Magnification	N.A.	W.D. (mm)	F (mm)	R (µm)	D.F. (µm)	F.D. (mm) (Ø24 eyepiece)	F.D. (VxH, mm) (1/2" CCD camera)	Mass (g)
378-800*	1x	0.025	11.0	200	11.0	440	Ø24	4.8x6.4	300
378-801	2x	0.055	34.0	100	5.0	91	Ø12	2.4x3.2	220
378-802-2	5x	0.14	34.0	40	2.0	14.0	Ø4.8	0.96x1.28	230
378-803-2	10x	0.28	33.5	20	1.0	3.5	Ø2.4	0.48x0.64	230
378-804-2	20x	0.42	20.0	10	0.7	1.6	Ø1.2	0.24x0.32	370
378-805-2	50x	0.55	13.0	4	0.5	0.9	Ø0.48	0.10x0.13	290
378-806-2	100x	0.70	6.0	2	0.4	0.6	Ø0.24	0.05x0.06	320

\* M Plan Apo 1x (378-800) should be used together with an appropriate polarizer for the microscope used.

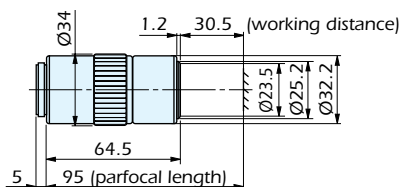
# M Plan Apo SL

1. Super-long working distance objectives (M Plan Apo SL200x: 13mm) for bright field observation.
2. The M Plan Apo (Apochromat) is an excellent optical system, with the flat and chromatic aberration free image over the entire field of view.

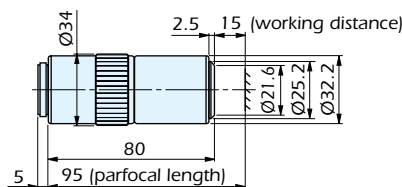
■ DIMENSIONS

\*Mounting screws 26, thread 36 (see P.24.)

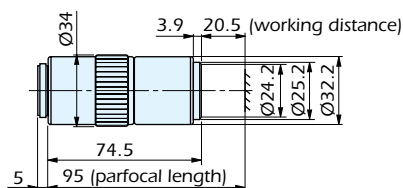
**M Plan Apo SL20x : 378-810-2**



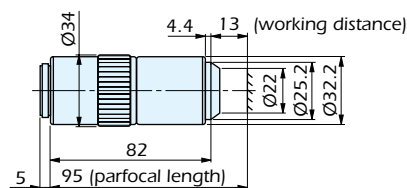
**M Plan Apo SL80x : 378-812-2**



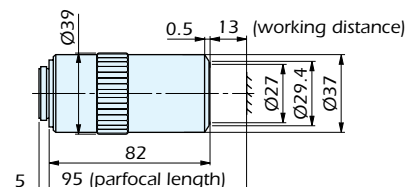
**M Plan Apo SL50x : 378-811-2**



**M Plan Apo SL100x : 378-813**



**M Plan Apo SL200x : 378-816**



Unit: mm

■ SPECIFICATIONS

Order No.	Magnification	N.A.	W.D. (mm)	F (mm)	R (μm)	D.F. (μm)	F.D. (mm) (Ø24 eyepiece)	F.D. (VxH, mm) (1/2" CCD camera)	Mass (g)
378-810-2	20x	0.28	30.5	10	1.0	3.5	Ø1.2	0.24x0.32	240
378-811-2	50x	0.42	20.5	4	0.7	1.6	Ø0.48	0.10x0.13	275
378-812-2	80x	0.50	15.0	2.5	0.6	1.1	Ø0.30	0.06x0.08	280
378-813	100x	0.55	13.0	2	0.5	0.9	Ø0.24	0.05x0.06	290
378-816	200x	0.62	13.0	1	0.4	0.7	Ø0.12	0.025x0.03	490

■ FEATURES

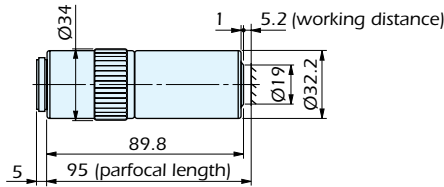
# M Plan Apo

1. High resolving power objectives (M Plan Apo 100x: N.A. 0.90) for bright field observation.
2. The M Plan Apo (Apochromat) is an excellent optical system, with the flat and chromatic aberration free image over the entire field of view.

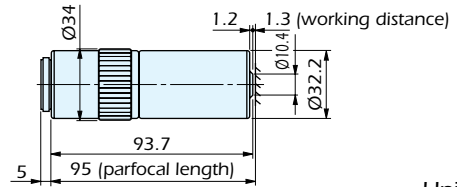
■ DIMENSIONS

\*Mounting screws 26, thread 36 (see P.24.)

**M Plan Apo 50x : 378-814**



**M Plan Apo 100x : 378-815**



Unit: mm

■ SPECIFICATIONS

Order No.	Magnification	N.A.	W.D. (mm)	F (mm)	R (µm)	D.F. (µm)	F.D. (mm) (Ø24 eyepiece)	F.D. (VxH, mm) (1/2" CCD camera)	Mass (g)
378-814*	50x	0.75	5.2	4	0.4	0.48	Ø0.48	0.10x0.13	330
378-815*	100x	0.90	1.3	2	0.3	0.34	Ø0.24	0.05x0.06	410

\* Available on "made-to-order" basis.

■ FEATURES

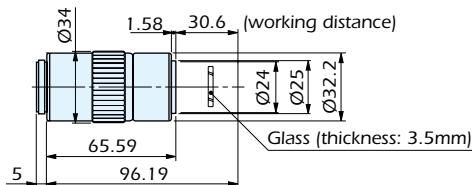
# G Plan Apo

1. Long working distance objectives (G Plan Apo 50x: 13.89mm) for bright field observation. These objectives allow observation of a specimen through a glass; they can be used to observe a specimen in a laboratory dish, a vacuum furnace, or various glass chambers.
2. Designed to correct a glass thickness of 3.5mm\*. Design and production to customer specifications available for correction of a glass thickness of 2mm to 5mm. Specify glass thickness.
3. The M Plan Apo (Apochromat) is an excellent optical system, with the flat and chromatic aberration free image over the entire field of view.

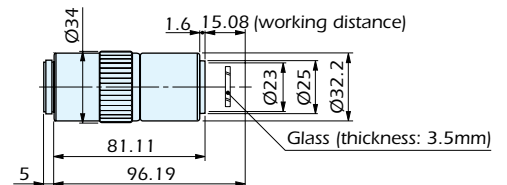
■ DIMENSIONS

\*Mounting screws 26, thread 36 (see P.24.)

**G Plan Apo 20x : 378-847**



**G Plan Apo 50x : 378-848**



Unit: mm

■ SPECIFICATIONS

Order No.	Magnification	N.A.	W.D.** (mm)	F (mm)	R (µm)	D.F. (µm)	F.D. (mm) (Ø24 eyepiece)	F.D. (VxH, mm) (1/2" CCD camera)	Mass (g)
378-847*	20x	0.28	29.42	10	1.0	3.5	Ø1.2	0.24x0.32	270
378-848*	50x	0.50	13.89	4	0.6	1.1	Ø0.48	0.10x0.13	320

\* Available on "made-to-order" basis.

\*\* Air conversion

## FEATURES

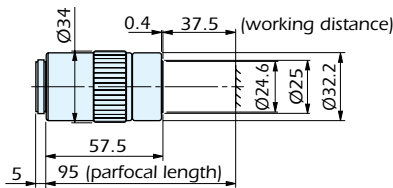
# M Plan NIR

1. Long working distance objectives (M Plan NIR 100x: 12mm) for bright field in laser cutting.
2. Designed to focus within the depth of focus, even when the laser wavelength used changes from the visible radiation (general inspection range) to the near-infrared radiation range (wavelength 1800nm).
3. Designed to improve the spectral transmission factor within near-infrared radiation. Most ideal when attached to the FS70L, VMU-L, or VMZ40 and used together with YAG laser (wavelength 1064nm), for cutting semiconductor circuits.

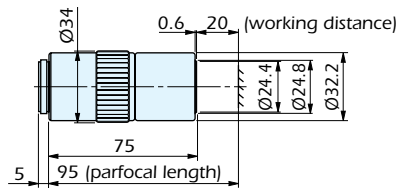
## DIMENSIONS

\*Mounting screws 26, thread 36 (see P.24.)

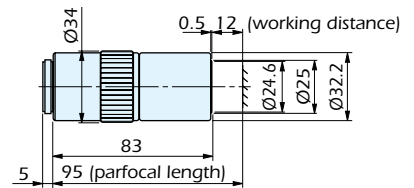
**M Plan NIR 5x : 378-822**



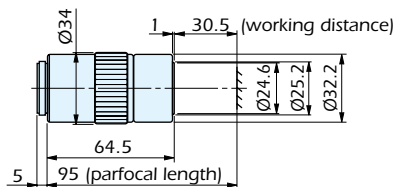
**M Plan NIR 20x : 378-824-1**



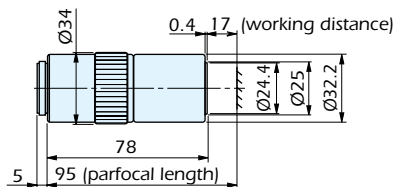
**M Plan NIR 100x : 378-826**



**M Plan NIR 10x : 378-823**



**M Plan NIR 50x : 378-825-1**



\*Depending on the focal point of the visible ray, when the wavelength exceeds 1100nm, a glass variance or an error that occurs in a measurement of the refractive index may cause the focus to shift.

Unit: mm

## SPECIFICATIONS

Order No.	Magnification	N.A.	W.D. (mm)	F (mm)	R (μm)	D.F. (μm)	F.D. (mm) (Ø24 eyepiece)	F.D. (VxH, mm) (1/2" CCD camera)	Mass (g)
378-822	5x	0.14	37.5	40	2.0	14.0	Ø4.8	0.96x1.28	220
378-823	10x	0.26	30.5	20	1.1	4.1	Ø2.4	0.48x0.64	250
378-824-1	20x	0.40	20.0	10	0.7	1.7	Ø1.2	0.24x0.32	300
378-825-1	50x	0.42	17.0	4	0.7	1.6	Ø0.48	0.10x0.13	315
378-826	100x	0.50	12.0	2	0.6	1.1	Ø0.24	0.05x0.06	335

## FEATURES

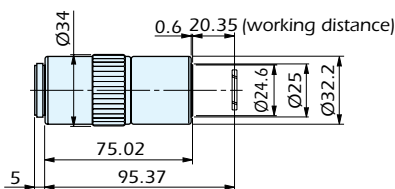
# LCD Plan NIR

1. Long working distance objectives (LCD Plan NIR 50x/t0.7: 17.26mm) designed for bright field observation through a glass in laser cutting.
2. These objectives correct the near-infrared radiation to be used for observation through a liquid crystal (thickness 1.1mm or 0.7mm) or for repair with a laser. Design and production of this type of lens with different glass thickness are also available.

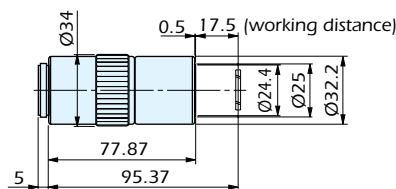
## DIMENSIONS

\*Mounting screws 26, thread 36 (see P.24.)

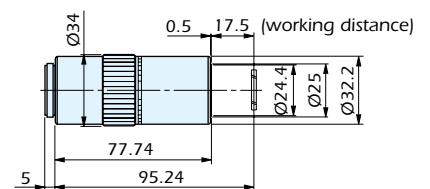
**LCD Plan NIR 20x/t1.1 : 378-827-1**



**LCD Plan NIR 50x/t1.1 : 378-828-1**



**LCD Plan NIR 50x/t0.7 : 378-829**



Unit: mm

## SPECIFICATIONS

Order No.	Magnification/galss thickness	N.A.	W.D.** (mm)	F (mm)	R (μm)	D.F. (μm)	F.D. (mm) (Ø24 eyepiece)	F.D. (VxH, mm) (1/2" CCD camera)	Mass (g)
378-827-1	20x/t1.1	0.40	19.98	10	0.7	1.7	Ø1.2	0.24x0.32	305
378-828-1	50x/t1.1	0.42	17.13	3.9	0.7	1.6	Ø0.48	0.10x0.13	320
378-829*	50x/t0.7	0.42	17.26	3.9	0.7	1.6	Ø0.48	0.10x0.13	320

\* Available on "made-to-order" basis.

\*\* Air conversion

Objectives with near-ultraviolet radiation correction for bright field

# M Plan NUV

Objectives with near-ultraviolet radiation correction for bright field through liquid crystal

# LCD Plan NUV

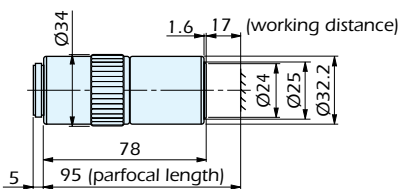
## FEATURES

1. Long working distance objectives (M Plan NUV 100x: 11mm) for bright field observation.
2. Designed to focus within the depth of focus, even when the laser wavelength used changes from the visible radiation (general inspection range) to the near-ultraviolet radiation range (wavelength 355nm).
3. These objectives correct the near-infrared radiation to be used for observation through a liquid crystal (thickness 0.7mm) or for repair with a laser. Design and production of this type of lens with different glass thickness are also available.
4. Designed to improve the spectral transmission factor within near-ultraviolet radiation range. Most ideal when attached to the FS70L and used together with YAG laser (wavelength 355nm), for cutting semiconductor circuits, as well as repairing liquid crystal color filters.

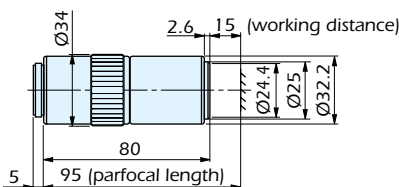
## DIMENSIONS

\*Mounting screws 26, thread 36 (see P.24.)

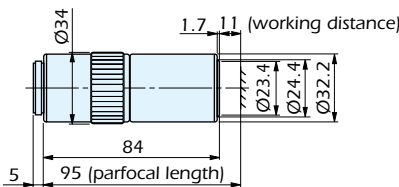
### M Plan NUV 20x : 378-817



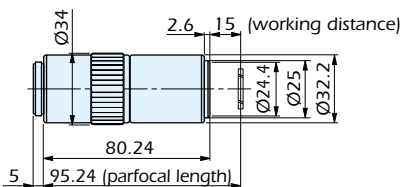
### M Plan NUV 50x : 378-818



### M Plan NUV 100x : 378-819



### LCD Plan NUV 50x/t0.7 : 378-820



Unit: mm

## SPECIFICATIONS

Order No.	Magnification/ galls thckness	N.A.	W.D. ** (mm)	F (mm)	R (µm)	D.F. (µm)	F.D. (mm) (Ø24 eyepiece)	F.D. (VxH, mm) (1/2" CCD camera)	Mass (g)
378-817	20x	0.40	17.0	10	0.7	1.7	Ø1.2	0.24x0.32	340
378-818	50x	0.42	15.0	4	0.7	1.6	Ø0.48	0.10x0.13	350
378-819	100x	0.50	11.0	2	0.6	1.1	Ø0.24	0.05x0.06	380
378-820*	50x/t0.7	0.42	14.76	4	0.7	1.6	Ø0.48	0.10x0.13	310

\* Available on "made-to-order" basis.

\*\* For 378-802 is "Air conversion".



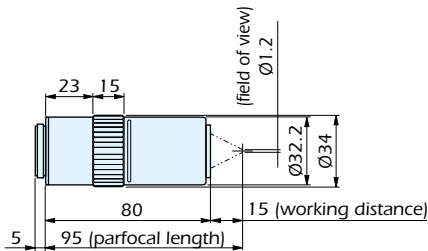
# M Plan UV

1. Long working distance objectives (M Plan UV 80x: 10mm) for bright field observation.
2. Designed to focus within the depth of focus, when either laser wavelength of the visible radiation (550nm) or ultraviolet radiation (266nm) is used. Improves the spectral transmission factors: 20x and 50x objectives by 80%, and 80x objective by 60% or higher.
3. Powerful when attached to the FS70L4, VMU-L4, VMZ40R-L4, or -BL4 and used together with YAG laser (wavelengths 532nm or 266nm), for cutting microscopic workpieces that require high-accuracy cutting, such as semiconductor protective film or semiconductor circuits.

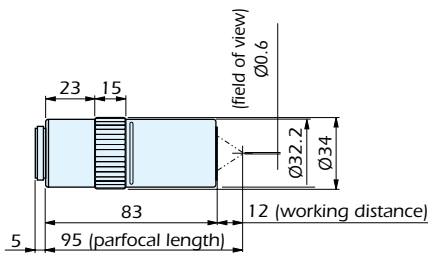
■ DIMENSIONS

\*Mounting screws 26, thread 36 (see P.24.)

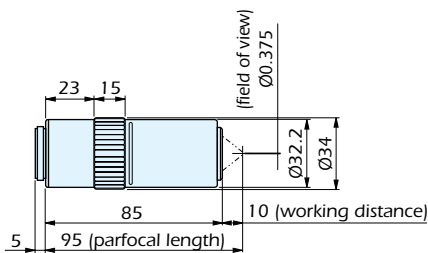
**M Plan UV 20x : 378-837**



**M Plan UV 50x : 378-838**



**M Plan UV 80x : 378-839**



Unit: mm

■ SPECIFICATIONS

Order No.	Magnification	N.A.	W.D. (mm)	F (mm)	R (µm)	D.F. (µm)	F.D. (mm) (Ø24 eyepiece)	F.D. (VxH, mm) (1/2" CCD camera)	Mass (g)
378-837	20x	0.36	15.0	10	0.8	2.1	Ø1.2	0.24x0.32	330
378-838	50x	0.40	12.0	4	0.7	1.7	Ø0.48	0.10x0.13	400
378-839	80x	0.55	10.0	2.5	0.5	0.9	Ø0.30	0.06x0.08	380

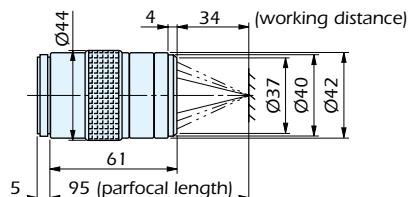
# BD Plan Apo

1. Long working distance objectives (BD Plan Apo 100x: 6mm) for both bright and dark field observations.
2. The special lenses and mirror in the optical tube make the ray of light fall obliquely on the specimen. Most ideal for observation of scratches and dents on the specimen surface.
3. The BD Plan Apo (Apochromat) is an excellent optical system, with the flat and chromatic aberration free image over the entire field of view.

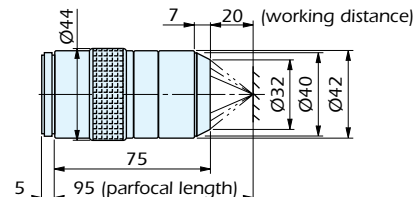
■ DIMENSIONS

\*Mounting screws 26, thread 36 (see P.24.)

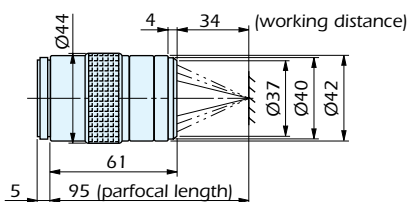
**BD Plan Apo 2x : 378-831**



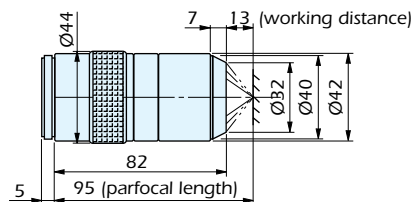
**BD Plan Apo 20x : 378-834**



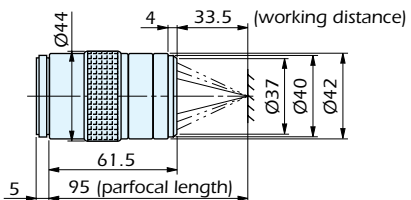
**BD Plan Apo 5x : 378-832**



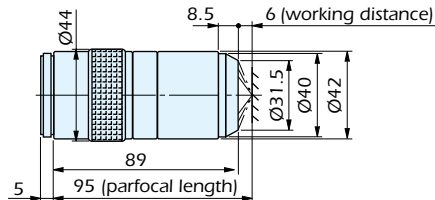
**BD Plan Apo 50x : 378-835**



**BD Plan Apo 10x : 378-833**



**BD Plan Apo 100x : 378-836**



Unit: mm

■ SPECIFICATIONS

Order No.	Magnification	N.A.	W.D. (mm)	F (mm)	R (µm)	D.F. (µm)	F.D. (mm) (Ø24 eyepiece)	F.D. (VxH, mm) (1/2" CCD camera)	Mass (g)
378-831	2x	0.055	34.0	100	5.0	91	Ø12	2.4x3.2	230
378-832	5x	0.14	34.0	40	2.0	14.0	Ø4.8	0.96x1.28	240
378-833	10x	0.28	33.5	20	1.0	3.5	Ø2.4	0.48x0.64	240
378-834	20x	0.42	20.0	10	0.7	1.6	Ø1.2	0.24x0.32	300
378-835	50x	0.55	13.0	4	0.5	0.9	Ø0.48	0.10x0.13	320
378-836	100x	0.70	6.0	2	0.4	0.6	Ø0.24	0.05x0.06	320

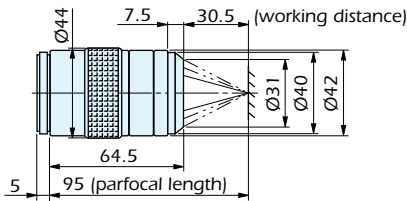
**FEATURES**

# BD Plan Apo SL

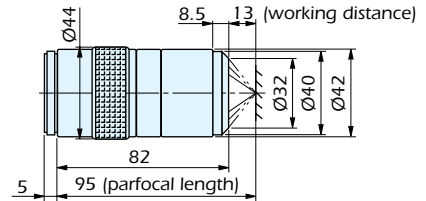
1. Super-long working distance (BD Plan Apo SL100x: 13mm) objectives for both bright and dark field observations.
2. The special lenses and mirror in the optical tube make the ray of light fall obliquely on the specimen. Most ideal for observation of scratches and dents on the specimen surface.
3. The M Plan Apo (Apochromat) is an excellent optical system, with the flat and chromatic aberration free image over the entire field of view.

**DIMENSIONS** \*Mounting screws 40, thread 36 (see P.24.)

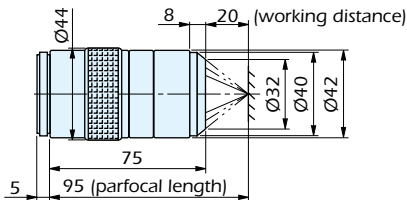
**BD Plan Apo SL20x : 378-840**



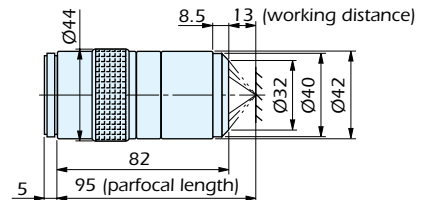
**BD Plan Apo SL80x : 378-842**



**BD Plan Apo SL50x : 378-841**



**BD Plan Apo SL100x : 378-843**



Unit: mm

**SPECIFICATIONS**

Order No.	Magnification	N.A.	W.D. (mm)	F (mm)	R (µm)	D.F. (µm)	F.D. (mm) (Ø24 eyepiece)	F.D. (VxH, mm) (1/2" CCD camera)	Mass (g)
378-840	20x	0.28	30.5	10	1.0	3.5	Ø1.2	0.24x0.32	240
378-841	50x	0.42	20.5	4	0.7	1.6	Ø0.48	0.10x0.13	310
378-842	80x	0.50	15.0	2	0.6	1.1	Ø0.30	0.06x0.08	310
378-843	100x	0.55	13.0	2	0.5	0.9	Ø0.24	0.05x0.06	320

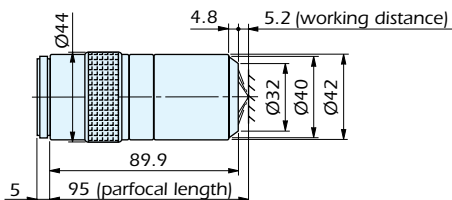
**FEATURES**

# BD Plan Apo

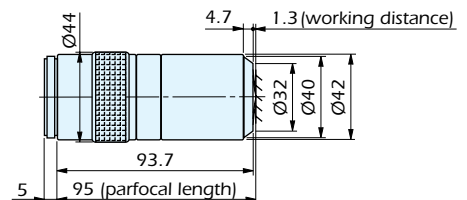
1. High resolving power objectives (BD Plan Apo 100x: N.A. 0.90) for both bright and dark field observations.
2. The special lenses and mirror in the optical tube make the ray of light fall obliquely on the specimen. Most ideal for observation of scratches and dents on the specimen surface.
3. The M Plan Apo (Apochromat) is an excellent optical system, with the flat and chromatic aberration free image over the entire field of view.

**DIMENSIONS** \*Mounting screws 40, thread 36 (see P.24.)

**BD Plan Apo 50x : 378-845**



**BD Plan Apo 100x : 378-846**



Unit: mm

**SPECIFICATIONS**

Order No.	Magnification	N.A.	W.D. (mm)	F (mm)	R (µm)	D.F. (µm)	F.D. (mm) (Ø24 eyepiece)	F.D. (VxH, mm) (1/2" CCD camera)	Mass (g)
378-845*	50x	0.75	5.2	4	0.4	0.48	Ø0.48	0.10x0.13	370
378-846*	100x	0.90	1.3	2	0.3	0.24	Ø0.24	0.05x0.06	435

\* Available on "made-to-order" basis.

## FEATURES

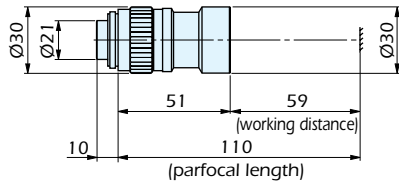
# Standard objectives for finity correction system

- Objectives for measuring applications. Employing the telecentric system (1x, 3x, 5x, and 10x lenses only) that minimizes lateral aberrations and prevents the image size from varying when the focus is lost.
- Employing finity correction system.  
(Distance between specimen and image: 280mm)  
(Distance between the lens mounting surface and the workpiece surface: 110mm)
- Long working distance (1x objective: 59mm) makes these lenses ideal for integration into a measuring system.

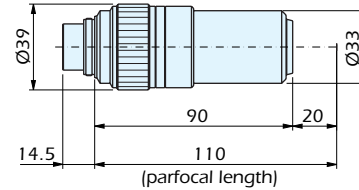
## DIMENSIONS

\*Mounting screws 26, thread 36 (see P.24.)

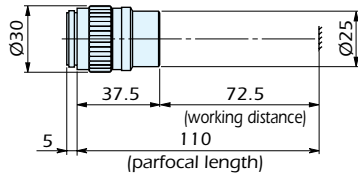
**Objective 1x : 375-036**



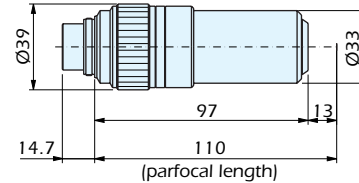
**Objective 20x : 375-051**



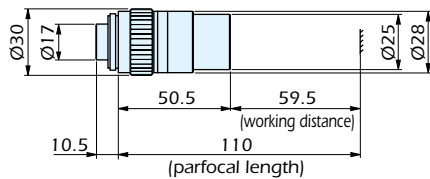
**Objective 3x : 375-037**



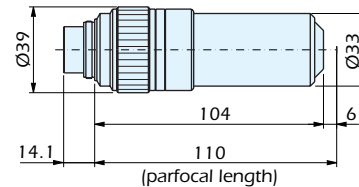
**Objective 50x : 375-052**



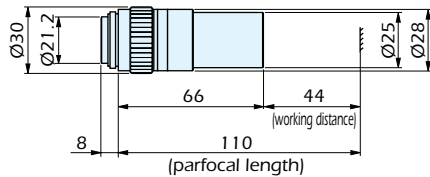
**Objective 5x : 375-034**



**Objective 100x : 375-053**



**Objective 10x : 375-035**



Unit: mm

## SPECIFICATIONS

Order No.	Magnification	N.A.	W.D. (mm)	R (μm)	D.F. (μm)	F.D. (mm) (Ø24 eyepiece)	F.D. (VxH, mm) (1/2" CCD camera)	Mass (g)
375-036	1x	0.03	59.0	9.2	306	Ø24	4.8x6.4	110
375-037	3x	0.07	72.5	3.9	56	Ø8	1.6x2.1	45
375-034	5x	0.11	59.5	2.5	23	Ø4.8	0.96x1.28	80
375-035	10x	0.18	44.0	1.5	8.0	Ø2.4	0.48x0.64	100
375-051	20x	0.42	20.0	0.7	1.6	Ø1.2	0.24x0.32	310
375-052	50x	0.55	13.0	0.5	0.9	Ø0.48	0.10x0.13	350
375-053	100x	0.70	6.0	0.4	0.6	Ø0.30	0.06x0.08	380

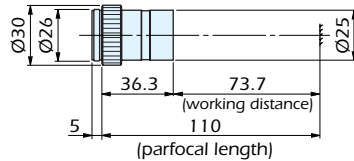
## FEATURES

# Compact objectives for finity correction system

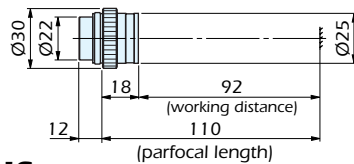
## DIMENSIONS

\*Mounting screws 26, thread 36 (see P.24.)

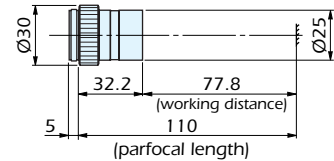
### Objective 1x : 375-031



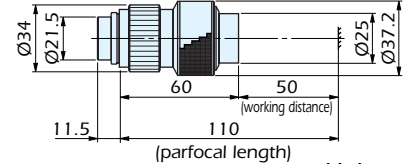
### Objective 2x : 375-032



### Objective 3x : 375-033



### Zoom objective 1x~5x : 375-038



Unit: mm

## SPECIFICATIONS

Order No.	Magnification	N.A.	W.D. (mm)	R (μm)	D.F. (μm)	F.D. (mm) (Ø24 eyepiece)	F.D. (VxH, mm) (1/2" CCD camera)	Mass (g)	
375-031	1x	0.03	73.7	9.2	306	Ø24	4.8x6.4	45	
375-032	2x	0.06	92.0	4.6	76	Ø12	2.4x3.2	35	
375-033	3x	0.07	59.5	2.5	23	Ø4.8	0.96x1.28	35	
375-038	1x - 5x	1x	0.04	50.0	6.90	27	Ø24	4.8x6.4	200
		3x	0.10	50.0	2.75	27	Ø8	1.6x2.1	
		5x	0.10	50.0	2.75	27	Ø4.8	0.96x0.64	

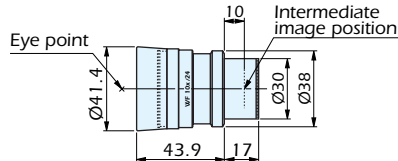
## FEATURES

- Wide field of view eyepieces (375-031 : 24mm).
- The external focusing system makes the installation of reticle easy. Various types of reticle are available for the purpose to be used.

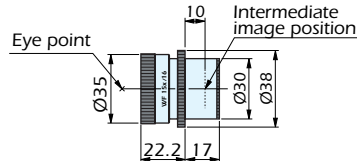
# Wide field of view eyepieces

## DIMENSIONS

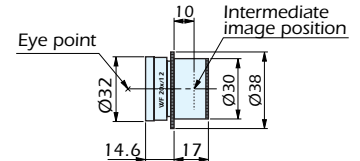
### WF 10x/24 : 378-856



### WF 15x/16 : 378-857



### WF 20x/12 : 378-858



Unit: mm

## SPECIFICATIONS

Order No.*	Magnification	Field number	Visibility adjustment	High eye point	Reticle	Mass (g)
378-856	10x	24	-8D to +5D	○	Available	45
378-857	15x	16	-8D to +5D	—	Available	35
378-858	20x	12	-8D to +5D	—	Available	35

\* Sold as a set of 2 pieces.

## FEATURES

- A reticle can be inserted into the position of an intermediate image for simple measurement.
- Reticle line widths 7μm (516576) and 10μm (others) to suit the microscopic size specimen.

# RETICLES

## DIMENSIONS

\*Outside diameter Ø25mm, thickness 1mm

### 516848



90° full lines

### 516576



90°, 60° chain lines

### 516578



Concentric circles with crossing lines  
(P=Ø1.2/Ø1.2 - 18mm)

### 516577



Graduation line with crossing lines  
(P=0.1/20mm)

### 516849



Graduation line  
(P=0.1/10mm)

### 516850



Graduation line  
(P=0.05/5mm)

### 516851

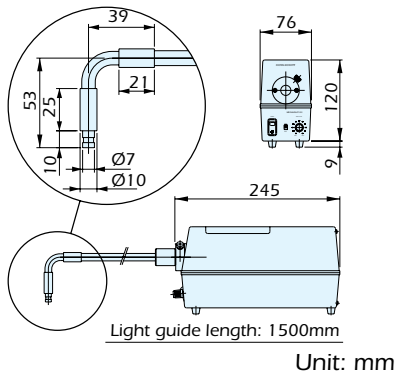


Grids  
(P=□ 1mm/□ 10mm)

# ILLUMINATION SYSTEMS

**Note:** To denote your AC line voltage add the following suffixes (e.g. 378-200A).  
**A** for 120V, **C** for 110V, **D** for 220V, **E** for 240V. **No suffix** is required for 100V

## Fiber illuminator : 378-700



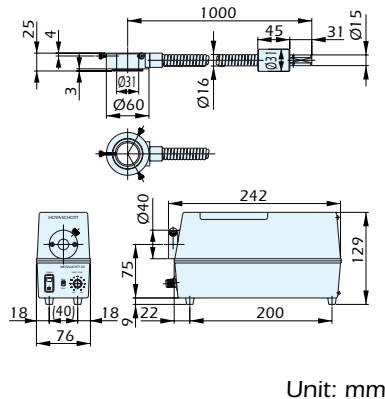
### SPECIFICATIONS

Light source	Halogen bulb (517181, 12V/100W, 100h service life)
Light guide	1500mm fiber cable (5mm dia.)
Brightness	Adjustable by volume
Optional LB80 filters	Color/temperature conversion filter
	ND2 For 1/2 light volume
	ND8 For 1/8 light volume
	GIF Green filter

\* See P.26 for the illustration of the fiber illuminator installed in a microscope unit.

## Ring fiber illuminator : 176-366

Mount the ring fiber illuminator on a standard objective (1x, 3x, 5x, 10x) or a compact objective for finity correction system. (See P.17 and P.18.)



### SPECIFICATIONS

Light source	Halogen bulb (517181, 12V/100W, 100h service life)
Light guide	1000mm fiber cable (7.1mm dia.)
Oblique light unit	OD of fiber: 35.4mm ID of fiber: 34.6mm
Brightness	Adjustable by volume

# MONITOR SYSTEM

## Color CCD monitor system

1/2 inch, 410,000 pixel CCD camera employed. The ultra-fine, position-adjustable vertical and horizontal reference lines (two lines in each direction) can be generated and projected on the workpiece image displayed.



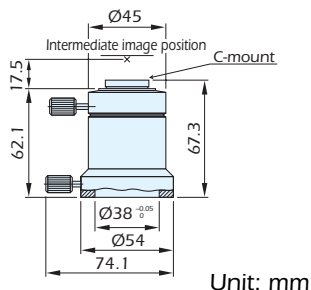
Example of system composition with VMZ40R-BL

Signal type	NTSC
Camera unit	1/2 single board CCD
Pixel	410,000 pixels
Hor. resolution	450 line
Camera mount	C-mount
Applicable microscope	VMU, FS70, VM-ZOOM

# TV CAMERA ADAPTER, POLARIZER, STAND, DIC UNIT

## Adapter B (378-042)

CCD camera adapter for the FS70Z.



## Polarizer

For polarized observation with the FS70.



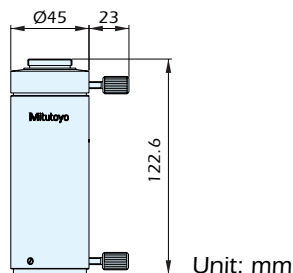
For FS70Z : 378-092

For FS70L : 378-093

For FS70L4 : 378-094

## 0.5x TV adapter (375-054)

With this adapter, the reduced (0.5x) workpiece image can be displayed on the TV monitor, allowing observation over a wide field of view. Use together with Adapter B.



## Stand (378-731)

For mounting the VMU, FS70, or VM-ZOOM microscope unit. Can be combined with a X-Y table and micrometer heads to work as a complete microscope reflective illumination.



## Differential Interference Contrast (DIC) unit (Available on "made to order" basis)

Use it in combination with a polarizer, for Differential Interference Contrast observation with the FS70Z.

Order No.	Applicable objectives
378-076	M/G Plan Apo 100x, M Plan Apo SL80x/50x
378-078	M/G Plan Apo 50x, M Plan Apo SL20x
378-079	M/G Plan Apo 20x
378-080	M/G Plan Apo 10x/5x



# REFERENCE : PLACEMENT OF LENSES

The VMU, FS70, and VM-ZOOM series microscope units employ the infinity correction system, in which an objective and a tube lens form an image. This is a most ideal optical system for metallurgical microscopes. This system eliminates ghosts caused by a half mirror for reflective illumination and also eliminates image position shifts caused by prisms and filters. When designing your original microscope system using Mitutoyo's long working-distance objectives, use these tube lenses.

## ■ PLACEMENT OF OBJECTIVE AND TUBE LENS

Mitutoyo's long working-distance objective lenses are designed to cover a field of view of up to  $\varnothing 30\text{mm}$ , when the tube lens MT-1 or MT-2 is placed at the specified distance from the objective. However, use the following formula to calculate the approximate distance, when a distance other than that as specified is required in order to insert your own optical system or other optical elements:

$$\ell = (\varnothing_2 - \varnothing_1) \cdot f_2 / \varnothing \quad (1)$$

$$\varnothing_1 = 2 \cdot f \cdot \text{N.A.} \quad (2)$$

- $\varnothing_1$  : Objective exit pupil diameter (mm)
- $\varnothing_2$  : Light incident lens (tube lens) diameter (mm)
- $f_2$  : Focal length of tube lens
- $\varnothing$  : Image field

Example: What is the distance ( $\ell$ ), when using M Plan Apo 10x and MT-1 to cover an image field of  $\varnothing 24$ ?

$$\text{From (2): } \varnothing_1 = 2 \times 20 \times 0.28 = 11.2 \text{ (mm)}$$

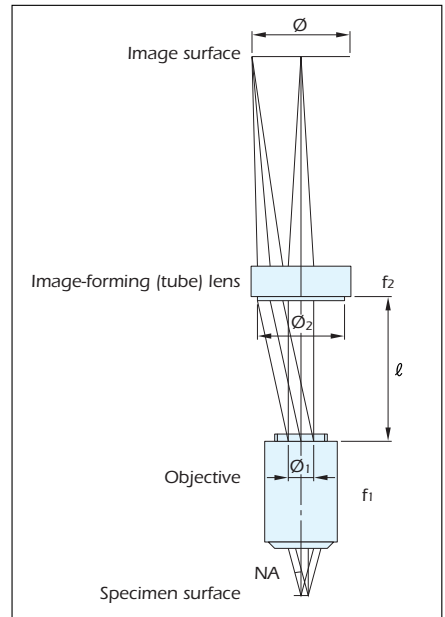
\*From the M Plan Apo 10x specifications on P.9; focal length ( $f$ ) = 20mm, numerical aperture (N.A.) = 0.28

$$\text{From (1): } \ell = (24 - 11.2) \times 200 / 24 = 106.6 \text{ (mm)}$$

A distance up to  $\ell = 106\text{mm}$  can cover an image field of  $\varnothing 24$  without shading.

\* MT-1's incident lens diameter  $\varnothing_2 = 24\text{mm}$ , focal length  $f_2 = 200\text{mm}$  (See specifications on P.21.)

A distance smaller than the specification does not affect an optical performance. Contact us for detailed information.



## ■ PLACEMENT OF OBJECTIVE AND TUBE LENS WITH USE OF LASER

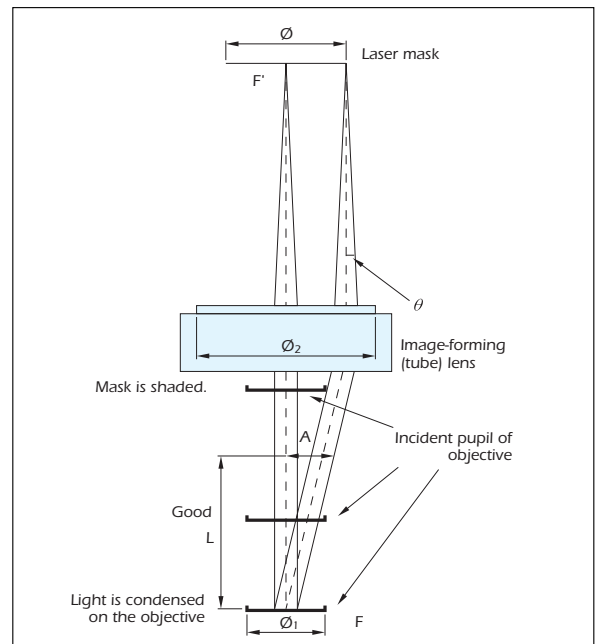
When a masking is used in laser cutting, you can construct your original optical system using Mitutoyo's tube lenses for laser cutting. Determine the positions of the objective and the tube lens in the following manner:

- Incident lens diameter of the tube lens has to be:  
 $\varnothing_2 > \varnothing + 2 \cdot f \cdot \tan U$
- Focal length of the tube lens: When A is the distance between the outermost beam at L (distance from the tube lens focal point F) and the optical axis,  
 $A = (L \cdot \varnothing) / (2 \cdot f) + f \cdot \tan U$

At this position, if  $\varnothing_1 > 2A$ , the workpiece can be cut without shading the mask.

When the objective incident pupil becomes closer to the focal point ( $F$  ( $L=0$ )), the laser beam is condensed on the objective lens. This will cause the laser energy density to rise, possibly resulting in the damaging of the objective.

See P.23 for conditions for laser beam emission through an objective.  
\*Avoid contamination of the surface of a lens that is within the laser beam path range, since it often causes damage to the lens.



- $\varnothing$ : Laser mask diameter
- $2U$ : Diffusion angle of laser beam
- $\varnothing_2$ : Incident lens diameter of tube lens
- $f$ : Focal length of tube lens
- $\varnothing_1$ : Incident pupil diameter of objective

## FEATURES

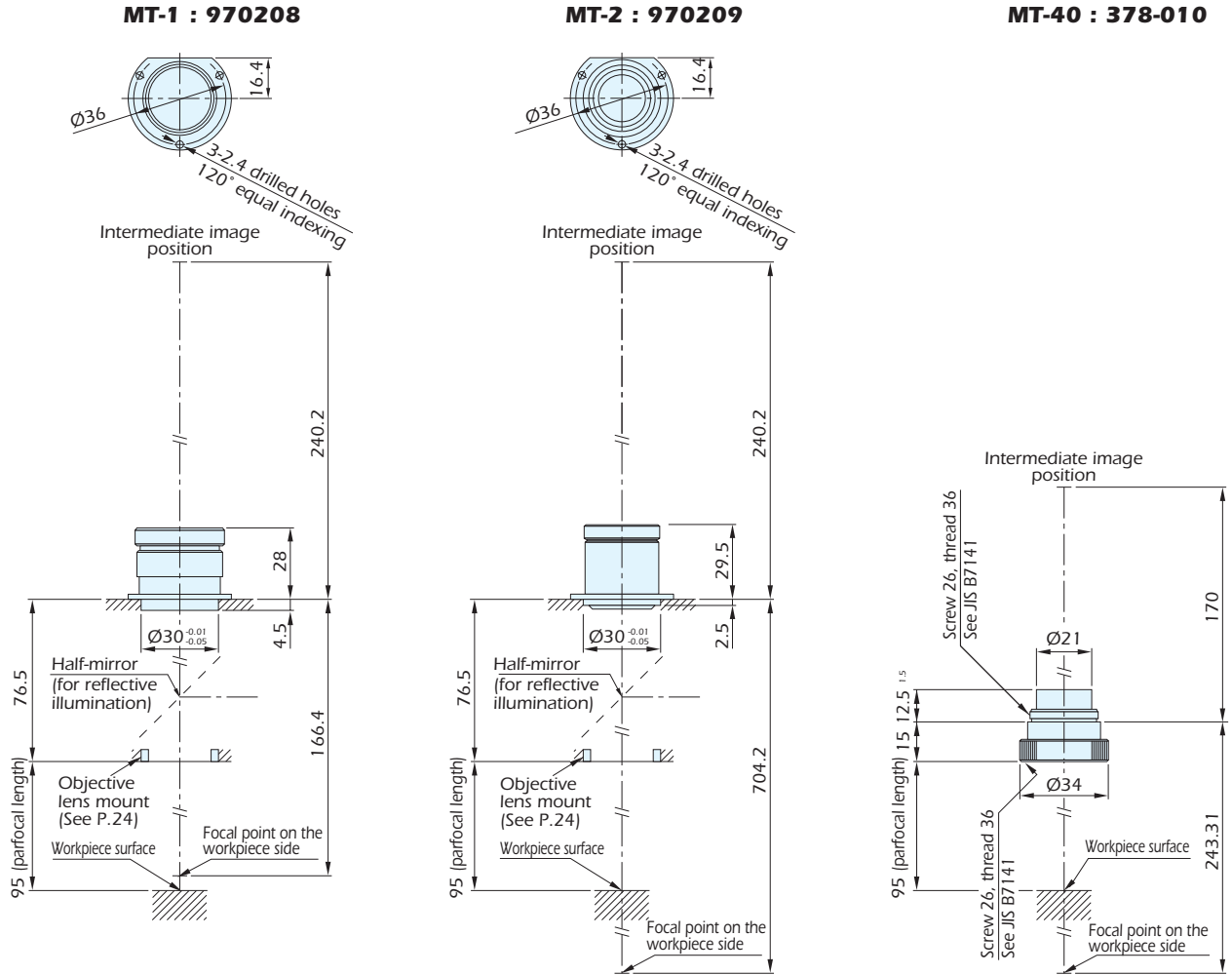
# Tube lens

MT-1, 2, 40 : For use in the visible wavelength range. Aberration correction range: 435.8 – 656.3nm.

MT-L : Corrects aberration in ranges from the near-ultraviolet (355nm) to the visible (620nm).

MT-L4 : Corrects aberration in ranges from the ultraviolet (266nm) to the visible (620nm).

## DIMENSIONS



Unit: mm

## SPECIFICATIONS

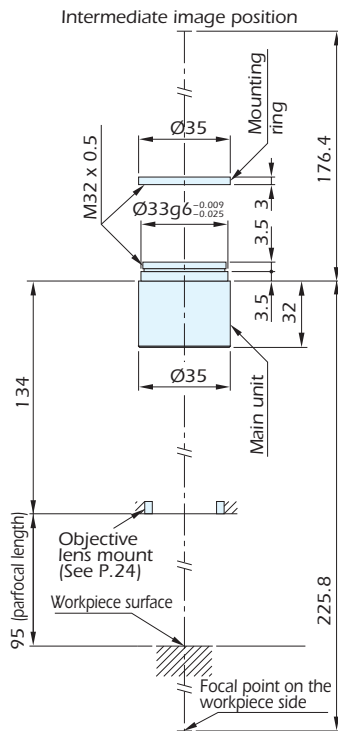
Order No.	Focal length	Tube lens mag.	Image field (mm)	Incident lens dia. (mm)	Dimensions (mm)	Mass (g)
970208	200	1x	Ø30	Ø24	Ø40x32.5	43
970209	400	2x	Ø30	Ø18	Ø40x32.0	42
378-010	200	1x	Ø24	Ø11.2	Ø34x27.5	45

Note: A distance 76.5mm in the MT-1 and MT-2 drawings is for an image field of Ø30 (without shading). For an image field of Ø24 or Ø11 (the latter is the image field of a 2/3 inch CCD camera), use the formula on page 20 (1) and (2) to calculate the distance.

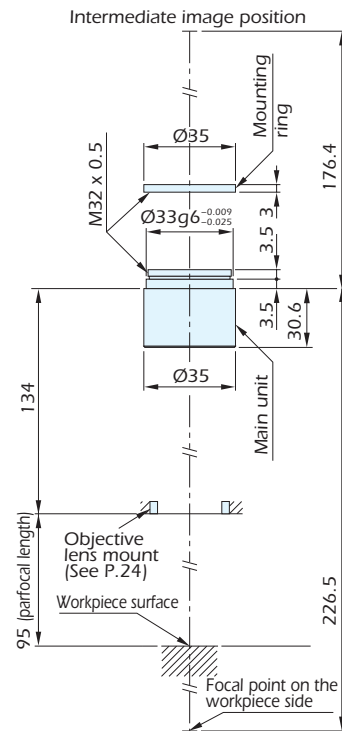


## ■ DIMENSIONS

**MT-L : 378-008**



**MT-L4 : 378-009**



Unit: mm

## ■ SPECIFICATIONS

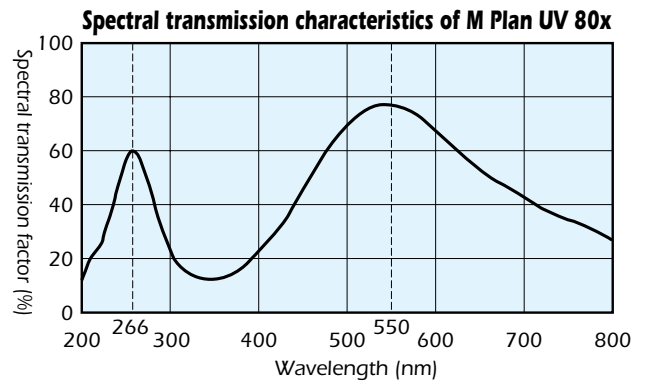
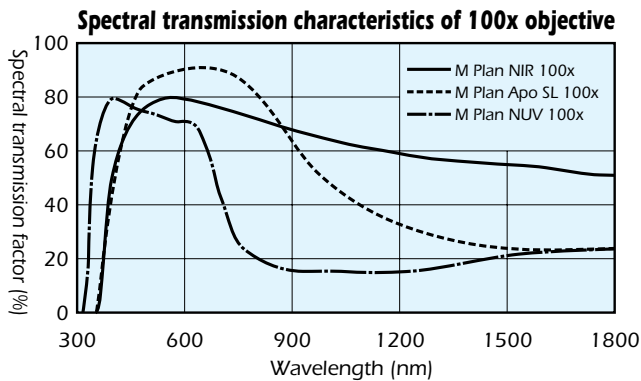
Order No.	Focal length	Tube lens mag.	Image field (mm)	Incident lens dia. (mm)	Dimensions (mm)	Mass (g)
378-008	200	1x	Ø24	Ø22	Ø35x32.0	30
378-009	200	1x	Ø24	Ø23	Ø35x30.6	30

# REFERENCE : OPTICAL CHARACTERISTICS OF OBJECTIVE

## ■ LIGHT TRANSMISSION

Mitutoyo's long working-distance objectives are grouped by wavelength ranges: near-infrared radiation range, visible range, near-ultraviolet radiation range, and ultraviolet radiation range. The M Plan NIR series (for near-infrared radiation correction), M Plan NUV series (for near-ultraviolet radiation correction), and M Plan UV series (for ultraviolet radiation correction) are designed especially for YAG laser cutting applications in cutting thin films. Each series is designed to improve the spectral transmission factor in its respective wavelength range.

1. Visible range: wavelength correction from 436nm to 656nm  
The M Plan Apo series objectives are designed for fundamental waves of 587nm. All objectives in this series employ the highest-class plan apochromat with little chromatic aberration for various inspections.
2. Near-infrared radiation range: wavelength correction from 480nm to 1800nm  
The M Plan NIR series objectives are designed for both inspection and laser cutting with an improved spectral transmission factor in the visible to near-infrared radiation ranges. These lenses allow cutting or trimming of semiconductor circuits, when combined with the YAG laser (wavelengths 1064nm or 532nm). They are designed to allow the workpiece image to be focused within the focal depth in the visible and near-infrared radiation ranges.
3. Near-ultraviolet radiation range: wavelength correction from 355nm to 620nm  
The M Plan NUV series objectives are designed for both inspection and laser cutting with an improved spectral transmission factor in the visible to near-ultraviolet radiation ranges. These lenses can be used in the passivation of semiconductor circuit insulation films or in repairing LCD color filters. They are designed to allow the workpiece image to be focused within the focal depth in the visible and near-ultraviolet radiation ranges.
4. Ultraviolet radiation range: 266nm & 550nm wavelength correction  
The M Plan NU series objectives are designed for both inspections and laser cutting that involve ultraviolet radiation. Designed to improve the spectral transmission factor in the ultraviolet range (wavelength 266nm) and the visible range (center wavelength 550nm). When used with the YAG laser (wavelength 266nm or 532nm), these lenses will improve performance and efficiency of the process.



## ■ CAUTIONS IN USING THE YAG LASER

Since laser cutting with microscopes is meant for cutting microscopic fine films used in semiconductors and liquid crystals, objectives are not designed to transmit a high-power laser beam. Therefore, when using the YAG laser, determine the level of laser output as follows:

YAG laser wavelength	Beam energy density (output)	Pulse width	Applicable objective
1064nm	0.2J/cm <sup>2</sup>	10ns	M Plan NIR
532nm	0.1J/cm <sup>2</sup>	10ns	
355nm	0.05J/cm <sup>2</sup>	10ns	M Plan NUV
266nm	0.04J/cm <sup>2</sup>	10ns	M Plan UV

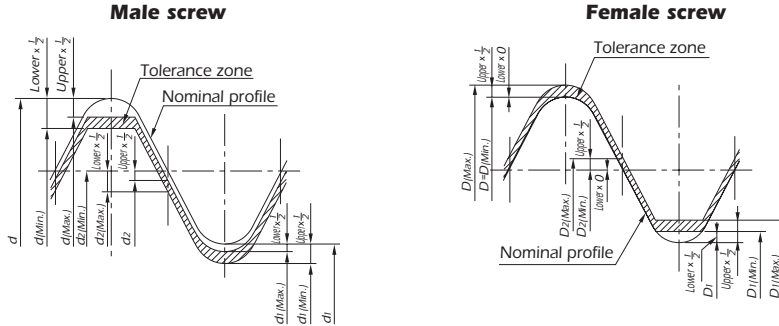
When the pulse width is shorter, multiply beam energy density by the square root of the ratio to 10ns.  
(Example) When pulse width of 1064nm YAG laser is 1/4, beam energy density is approximately lowered by 1/2 (= 0.1J/cm<sup>2</sup>).

Note) In order to prevent any unexpected damage to the equipment, consult your nearest Mitutoyo office for precautions before transmitting various laser beams through a microscope or objective.

# REFERENCE : MOUNTING SCREW STANDARDS

## Objective

1. Applicable range: For Mitutoyo microscope objectives.
2. Contours and dimensions in accordance with JIS B-7141-1988



## For objectives for bright field and objectives for finity correction system

Nominal sizes

Ø	n	P	R	Male/Female screw		
				O.D./R.D.	P.D./P.D.	R.D./I.D.
26	36	0.706	0.097	26.000	25.548	25.096

Limit of size and tolerance

Unit: mm

		Male screw			Female screw		
		O.D.	P.D.	R.D.	R.D.	P.D.	I.D.
Limit of size	Max.	25.896	25.502	25.050	26.076	25.624	25.230
	Min.	25.820	25.426	24.974	26.000	25.548	25.154
Tolerance	U	-0.104	-0.046	-0.046	+0.076	+0.076	+0.134
	L	-0.180	-0.122	-0.122	+0.000	+0.000	+0.058

## For objectives for bright field/dark field

Nominal sizes

Ø	n	P	R	Male/Female screw		
				O.D./R.D.	P.D./P.D.	R.D./I.D.
40	36	0.706	0.097	40.00	39.548	39.096

Limit of size and tolerance

Unit: mm

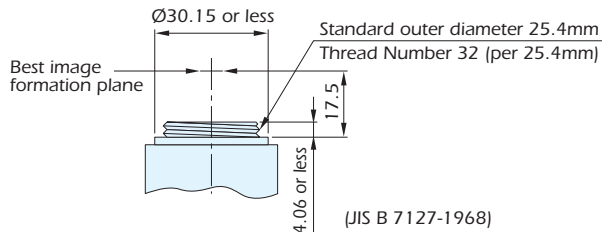
		Male screw			Female screw		
		O.D.	P.D.	R.D.	R.D.	P.D.	I.D.
Limit of size	Max.	39.896	39.502	39.050	40.076	39.624	39.230
	Min.	39.820	39.426	38.974	40.000	39.548	39.154
Tolerance	U	-0.104	-0.046	-0.046	+0.076	+0.076	+0.134
	L	-0.180	-0.122	-0.122	+0.000	+0.000	+0.058

- Ø: Diameter (mm)
- n: Number of thread per 25.4mm
- P: Pitch (mm)
- R: Roundness of crest and root
- O.D.: Outer diameter (mm)
- R.D.: Root diameter (mm)
- P.D.: Pitch diameter (mm)
- I.D.: Inner diameter (mm)

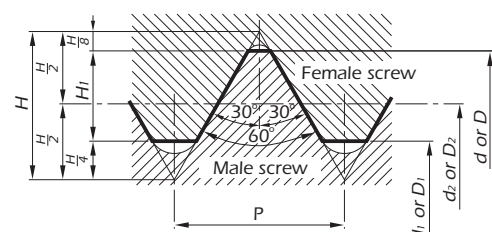
## C-MOUNT

1. Mount contour for 2/3" and 1/2" CCD Camera is the same as mount contour for 8mm and 16mm movie camera lenses (JIS B7127).
2. Screw contour is in accordance with JIS B0208.

### Mounting screw and flange focal length



### Nominal profile



Unit: mm

Unit: mm

	Ø	n	Pitch	Male screw			Female screw		
				O.D.	P.D.	R.D.	R.D.	P.D.	I.D.
Nominal size	25.4	32	0.794	25.400	24.884	24.541	25.400	24.884	24.541
Tolerance	—	—	—	-0.029	-0.027	-0.142	Not specified	+0.124	+0.199
	—	—	—	-0.180	-0.124	Not specified	Not specified	+0.000	-0.004

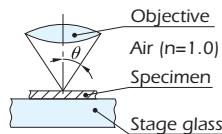
# GLOSSARY

## 1. N.A. : Numerical Aperture

N.A. determines resolving power, focal depth, and luminosity of the image. The larger N.A. is, the higher resolving power and smaller focal depth are.

$$\text{N.A.} = n \cdot \sin \theta$$

$n$  is an index of refraction made by the medium between an objective and a specimen.  $n=1.0$  for air.  $\theta$  is an angle made by the ray of light that goes through one end of an objective and an optical axis.



## 2. R : Resolving Power

Minimum space distinguishable between points or lines. Resolving power is determined by N.A. and wavelength  $\lambda$ .

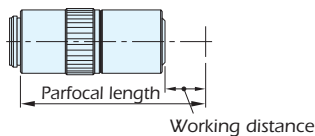
$$R (\mu\text{m}) = \frac{\lambda}{2 \cdot \text{N.A.}} \quad \lambda = 0.55 \mu\text{m} \text{ (Standard wavelength)}$$

## 3. W.D. : Working distance

Distance between the surface of the specimen and the surface of the objective when in focus.

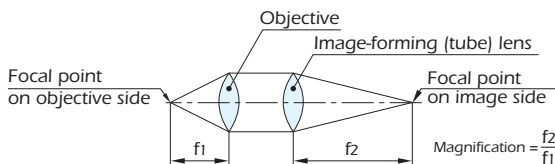
## 4. Parfocal Length

Distance between the surface of the specimen and the objective mounting position when in focus.



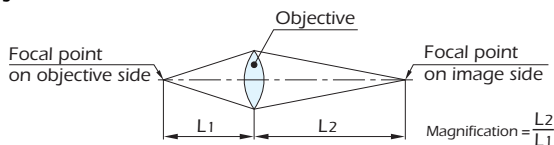
## 5. Infinity correction system

An optical system in which the image is formed by an objective and a tube lens.



## 6. Finitly correction system

An optical system in which the image is formed only by an objective.



## 7. F : Focal Length

Distance between a principal point and a focal point.  $f_1$  is a focal length of objective,  $f_2$  is a focal length of tube lens. Magnification is determined by the ratio of objective focal length and tube lens focal length. (For infinity correction system)

$$\frac{\text{Focal length of tube lens}}{\text{Focal length of objective}}$$

$$\text{(Ex.) } 1x = \frac{200 \text{ (mm)}}{200 \text{ (mm)}} \quad \text{(Ex.) } 10x = \frac{200 \text{ (mm)}}{20 \text{ (mm)}}$$

## 8. Real field of view

(1) Range (diameter) of specimen observable with a microscope.

$$\text{Real field of view (mm)} = \frac{\text{Field number of eyepiece}}{\text{Magnification of objective}}$$

\*Field number of eyepiece is 24 (mm)

$$\text{(Ex.) Real field of view for 1x objective is } \frac{24 \text{ (mm)}}{1} = 24 \text{ (mm)}$$

$$\text{Real field of view for 10x objective is } \frac{24 \text{ (mm)}}{10} = 2.4 \text{ (mm)}$$

(2) Range of specimen observable on TV monitor

$$\text{Real field of view (mm)} = \frac{\text{Size of CCD Camera image element}}{\text{Magnification of objective}}$$

\*Size of 1/2" CCD image element is 4.8 x 6.4 (mm)

(Ex.) Real field of view for 1x objective is 4.8 x 6.4 (mm)

Real field of view for 10x objective is 0.48 x 0.64 (mm)

## 9. D.F. : Depth of focus

Range around the focal point in which the image is still clear. The larger the N.A., the smaller the focal depth.

$$\text{D.F. } (\mu\text{m}) = \frac{\lambda}{2 \cdot (\text{N.A.})^2} \quad \lambda = 0.55 \mu\text{m} \text{ (Standard wavelength)}$$

(Ex.) N.A. of M Plan Apo 100x is 0.7

$$\text{Focal depth in this case is } \frac{0.55 \text{ } (\mu\text{m})}{2 \times 0.72} = 0.6 \text{ } (\mu\text{m})$$

## 10. Bright field illumination and dark field illumination

In bright field illumination the ray of light incident upon the object goes through the objective (the ray of light incident upon the object is parallel to the optical axis). In the dark field illumination, the ray of light does not go through the objective (the ray of light incident upon the object is at an angle from the optical axis); therefore, scratches and dents on the specimen surface are illuminated while the other, intact part remains dark.

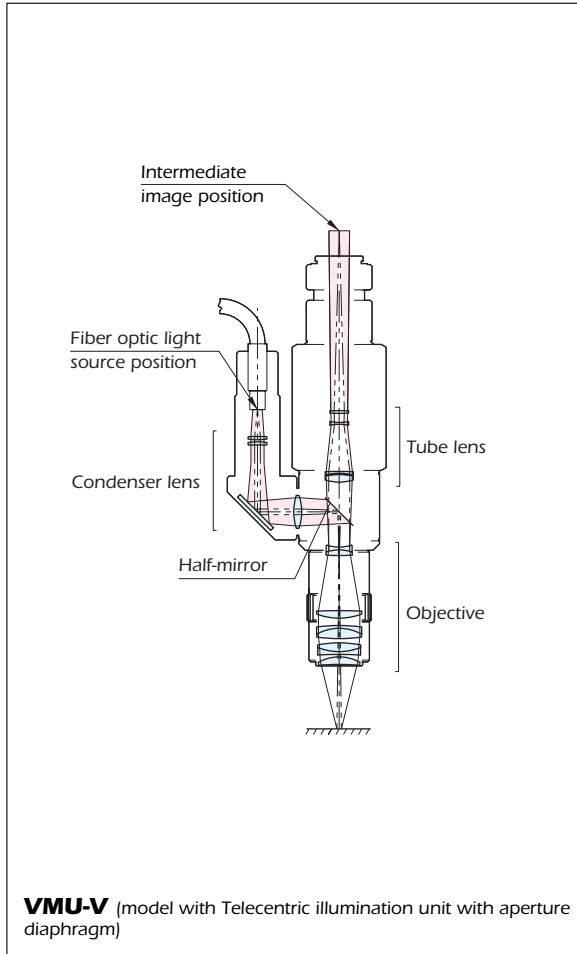
## 11. Apochromatic objective and achromatic objective

Apochromatic objective is chromatic aberration corrected for red, blue, and yellow.

Achromatic objective is chromatic aberration corrected for red and yellow only.

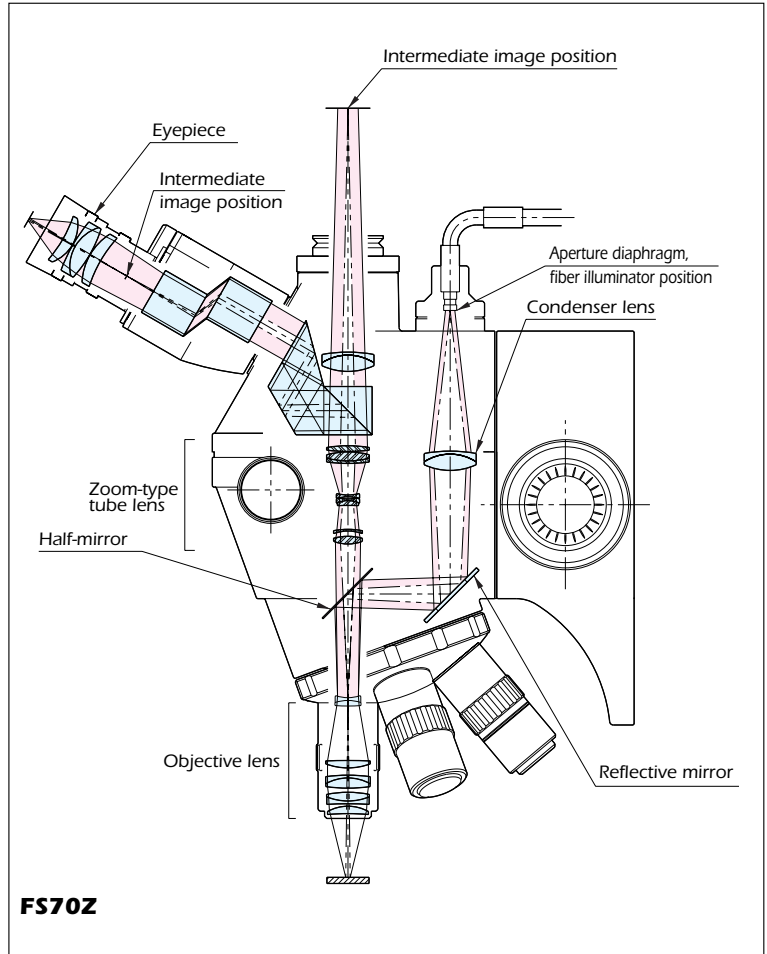
# OPTICAL SYSTEMS OF MICROSCOPE UNITS

Mitutoyo's microscopes employ the infinity correction system whose magnification is arbitrary and is determined by the combination of objective and tube lens, to allow clear images with little chromatic aberration. The optical systems of the two models that best represent Mitutoyo's various microscope units are shown below, as references. Refer to these when designing your original microscope optical system by inserting an optical element such as prism, half-mirror, etc., between the objective and the tube lens, where the light incident on the specimen is parallel to the optical axis.



- 1) The light beam emitted from the tip of the fiber is first diffused by the illumination system, reflected by the half-mirror, then forms its image of  $\text{Ø}1.2\text{mm}^*$  at the position of the exit pupil (approximately 5mm below the objective mounting surface). Subsequently, the light is transmitted through the objective, then illuminates the specimen.
- 2) The light reflected on the specimen is transmitted back through the objective and the half-mirror, then it is made to form the image of the specimen at the intermediate image position, by the tube lens.

\*The M Plan Apo 5x and 10x objectives have the largest exit pupil diameter. Contact Mitutoyo for inquiries concerning these lenses.



- 1) The light beam emitted from the tip of the fiber is first diffused by the condenser lens, reflected by the reflective mirror and the half-mirror, then forms its image of  $\text{Ø}1.2\text{mm}$  at the position of the exit pupil. Subsequently, the light is transmitted through the objective, then illuminates the specimen.
- 2) The light reflected on the specimen is transmitted back through the objective and the half-mirror, then it is made to form the image of the specimen by the zoom lens, at the two intermediate image positions shown above.

## Microscope FS300 Series



The most ideal microscope unit that makes inspection of 300mm IC wafer exteriors easier. In addition to the popular long working distance objectives, the body of this microscope is constructed as one piece, in which both high-rigidity and high resistance against vibration are combined, using a constructional analysis engineering technology.

## Measuring Microscope MF-H100



The long working distance objectives and the high-accuracy cross-travel stage make this model the most ideal microscope unit for measuring the line-width of IC circuits and dimensions of ultra-precision parts.

## Measuring Microscope MF-1000 Series



This model allows a clear, erect image with very little flaring in a wide field of view. It allows a maximum of 2000x magnification with the long working distance objectives.

## “EMISSION MICROSCOPE”, Analytical System with Long Working Distance Objective for Semiconductors

The Emission Microscope is an analytical system for semiconductors. It can locate an abnormality inside a semiconductor device by detecting extremely faint light ranging from visible ray to near-infrared ray.



Photograph provided by Hamamatsu Photonics

Specifications are subject to change without notice.

# Mitutoyo

PRECISION IS OUR PROFESSION

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