Mitutoyo

Mitutoyo Quality

MICROSCOPE UNITS AND OBJECTIVES
(UV, NUV, VISIBLE & NIR REGION)

Optical Measuring

PRE1457(2)

Many of today's ultra-microscopic manufacturing technologies require sub-micron accuracy.
Mitutoyo produces microscope systems with advanced features that combine optical and precision measurement technologies developed by us over a long period of time.
Mitutoyo microscopes can be integrated into manufacturing systems, research and development equipment, and product inspection lines.
Contact your nearest Mitutoyo Sales Office for further details on standard product specifications as well as custom-designed microscopes to best fit your application.

Ref.: "Microbio-World Ver.7,
(http://elfe.miyakyo-u.ac.jp/opac/2008/03/cd_2.html)


Mitutoyo
VMU
M Plan Apo NUV
10X / 0.28
∞ / 0 t=200
M Plan Apo
20X /
∞ / 0

A wealth of Applications

Digital camera

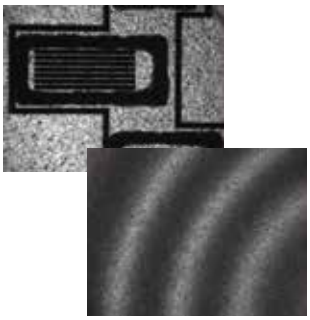
Digital microscopic system using VMU-V

By installing a digital camera on a microscope the VMU provides a simple and compact system which allows microphotography and simultaneous external monitor observations. The VMU can be used in vertical and horizontal positions according to your application requirements.

Using a simplified stand, it can be used as a compact microscope.

> Microphotography and observation of metallic, resinous and printed surfaces
> Micro-fluid analysis
> Cell and microorganism observation/analysis

IR analysis/inspection



Optical systems using Mitutoyo M Plan Apo NIR objectives that cover a wide range of wavelengths from visible to near-infrared are providing solutions on the production line and in the laboratory. Nondestructive inspection is made possible by using an infrared source.

> Thickness measurement of LCD thin-film and silicon board film
> Internal inspection/analysis and 3D evaluation of MEMS devices
> Internal observation of IC packages, void inspection/evaluation sensor of wafer junctions
> Spectral characteristics analysis using an infrared source

Laser applications

UV laser application using VMU-L4B
(Source of photographs: V-Technology Co.,Ltd.)

Flaking of polyimide membrane

SEM photograph of IC surface after removing upper layer

UV laser application using VMU-L4B
(Source of photographs: HOYA CANDEO OPTRONICS CORPORATION)

Color filter working

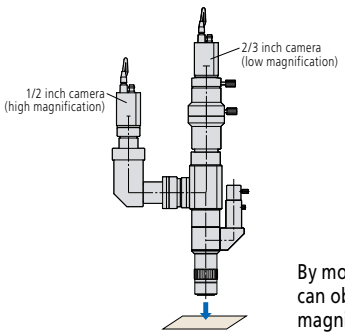
Objectives compatible with YAG lasers (1064 nm, 532 nm, 355 nm and 266 nm) allow high precision and quality working.

Using a simplified stand, it can be used as a compact microscope.

> Peeling off protective films and organic thin-films
> Cutting of IC wiring (Au, Al) and exposure of lower layer pattern
> FPD defects repair
> Photomask repair
> Marking, trimming, patterning, spot annealing and scribing

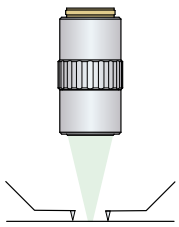
Various lasers are supported including femtosecond lasers.
(For details, please inquire).

Dual-camera (high & low magnification) observation



By mounting two cameras on VMU-LB you can observe the same area at different magnifications simultaneously.

Analysis



Probe (positioner tip)

The Mitutoyo M Plan Apo objectives provide a long working distance.
Best suited for use in combination with a positioner and probes.
Failure analysis is possible using a laser processing device.
A system that performs seamless partial correction can be supported.
A system that can be used for an appearance check through glass or in a vacuum chamber is also available.

Contents

Microscope for incorporating in equipment
VMU ····· 6

Wide field microscope unit for incorporating in equipment
WIDE VMU ····· 10

Fine Scope Unit
FS70 ····· 14

Objectives for Bright-field (long working distance)
M Plan Apo/M Plan Apo HR ····· 18

Objectives for Bright-field (super-long working distance)
M Plan Apo SL ····· 20

Objectives for Bright-field (with cover-glass thickness compensation)
G Plan Apo ····· 20

Objectives for Bright/Dark-field (long working distance)
BD Plan Apo ····· 21

Near-infrared Objectives for Bright-field
M Plan Apo NIR/M Plan Apo NIR HR, M Plan Apo NIR B ····· 22

Near-infrared Objectives for Bright-field (with cover-glass thickness compensation)
LCD Plan Apo NIR/LCD Plan Apo NIR HR ····· 23

Near-ultraviolet Objectives for Bright-field
M Plan Apo NUV/M Plan Apo NUV HR ····· 24

Near-ultraviolet Objectives for Bright-field (with cover-glass thickness compensation)
LCD Plan Apo NUV/LCD Plan Apo NUV HR ··· 25

Ultraviolet Objectives for Bright-field
M Plan UV ····· 26

Ultraviolet Objectives for Bright-field (with cover-glass thickness compensation)
LCD Plan UV ····· 27

Tube lens
MT ····· 28

Objectives for measuring microscopes
ML ····· 30

Objectives for centering microscopes
CF ····· 31

Wide field of view eyepieces & reticles
WF ····· 32

Optional accessories of VMU, WIDE VMU and FS70
Stand, Stage, Illumination Unit ····· 33

Dimensions (VMU/WIDE VMU/FS70) ····· 34

Reference:
Specifications of Objective Threads/ Transmission of Mitutoyo Objectives ····· 36

Commentary:
Laser Operating Method and Precautions ····· 37

Glossary ····· 38

NEW Wide field and high resolving power
Compatible with near-infrared observation

Wide field microscope unit for incorporating in equipment

WIDE VMU-HR

Wide field compatible with image field of ø30 mm

Homogeneous LED lighting brightens the field of view equally

Tube lens compatible with near-infrared

Space-saving compact body with a total length of 188.5 mm

Compatible with HR series of high resolving power lens

Note: Made to order

Mitutoyo

Microscope for incorporating in equipment

VMU

VMU-V

VMU-H

VMU-LB

VMU-L4B

Objectives shown mounted on tubes are optional.

Features

> Small, lightweight microscope unit designed for a camera observation system
Suitable for observing a wide range of objects: metal, resin, printed surfaces, minute mechanisms, etc.

> Can be used with YAG (near-infrared, visible, near-ultraviolet, or ultraviolet) lasers.*1
Suitable for cutting, trimming, repair and marking of IC wiring (Au, Al), removing and processing thin-film (insulating film) and repair of color filters (defects repair).

> Compatible with infrared optical systems*2
Available for internal observation of IC packages and spectral characteristics analysis using an infrared source and camera.

> Equipped as standard with a telecentric illumination system with aperture diaphragm
This is the best illumination system for image processing applications (e.g. dimension measurement, form inspection and positioning) which require even lighting.

> Extending the VMU series with high rigidity/performance VMU-LB and VMU-L4B models.

> Available for dual-camera (high & low magnification) observation (VMU-LB and VMU-L4B).

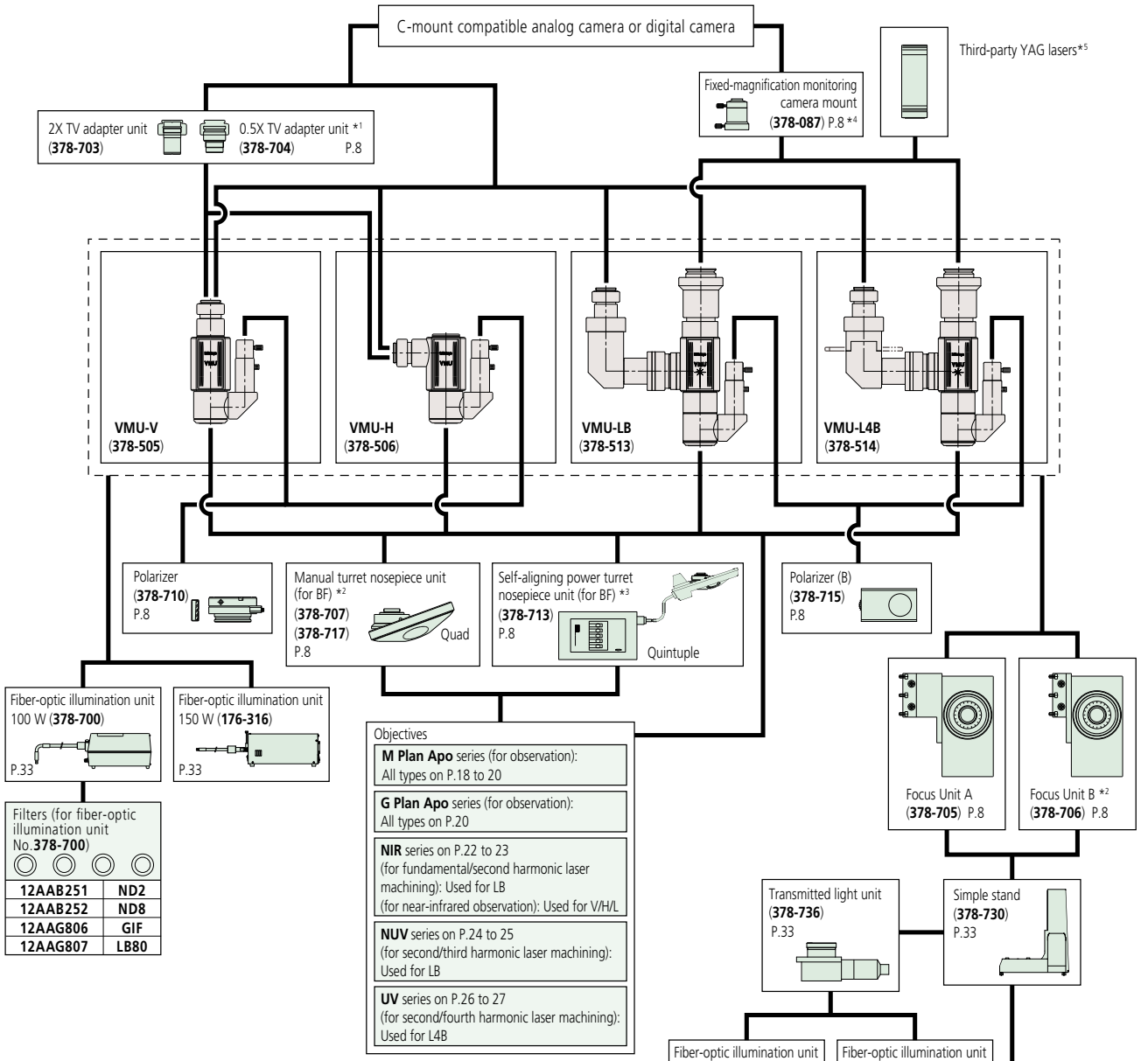
*1: The performance and safety of laser-equipped system products is not guaranteed.
*2: An infrared source and infrared camera are necessary.

Specifications

Model			VMU-V	VMU-H	VMU-LB	VMU-L4B
Order No.			**378-505**	**378-506**	**378-513**	**378-514**
Camera mounting orientation			Vertical	Horizontal	Vertical (rotatable)	
Observation			Bright-field	Bright-field	Bright-field	
Optical tube	Camera port	Optical features	Magnification: 1X; Wavelength (λ): visible radiation			
		Mount	C-mount (centering and parfocal adjustment)			C-mount with centering and parfocal adjustment and green filter switch
	Tube lens (correction range)		Built-in 1X (visible - NIR)		Built-in 1X (NUV - visible - NIR)	Built-in 1X (UV - visible - NIR)
	Laser port	Optical features	—		Magnification: 1X λ: 355/532/1064 nm	Magnification: 1X λ: 266/355/532/1064 nm
		Mount	—		With parfocal adjustment	
		Suitable YAG laser type *1	—		Fundamental, second and third-harmonic mode	Fundamental, second, third and fourth-harmonic mode
	Polarizer *1		Available for observation		Available for observation and laser applications	Available for observation and laser applications
Suitable objective (optional)		For observation	**M Plan Apo/HR/SL, G Plan Apo**			
		For laser cutting	—		**M/LCD Plan Apo NIR, M/LCD Plan Apo NUV** Note: Selected depending on the wavelength of the laser source	**M/LCD Plan Apo NIR, M/LCD Plan Apo NUV, M Plan UV** Note: Selected depending on the wavelength of the laser source
Suitable camera			2/3 inch or smaller C-mount compatible type			
Optical system illumination			Telecentric with aperture diaphragm			
Fiber-optic illuminator (optional)			12 V, 100 W (**378-700**), 15 V, 150 W (**176-316**)			
Mass (Dimensions: Refer to page 34.)			650 g	750 g	1270 g	1300 g

*1: M Plan Apo 1X objective should be used together with a polarizer (**378-710** or **378-715**).
Note: The following precautions when using VMU-LB or L4B with YAG laser source attached.
1. Be aware of the laser power and energy density. Otherwise, the optical system may be damaged.
2. Check the mass of the laser source. When mounting on a high-speed device or acceleration/deceleration device, please contact us.

System diagram



*1: Compatible with 1/2-inch or less C-mount cameras.
*2: Use focus unit B (**378-706**) if the distance between the mounting position and **VMU** main unit is desired to be as small as possible.
If the manual turret nosepiece unit (**378-707**) is used concurrently, mount the unit in front of the **VMU** main unit. For details on mounting position, refer to the figures on page 9.
*3: This turret nosepiece unit cannot be used with focus unit B (**378-706**).
For details on mounting position, refer to the figures on page 9.
*4: Use this mount when mounting a C-mount camera using the laser port.
Use this mount for 2/3-inch or smaller cameras.
*5: Mitutoyo does not handle these lasers. Consult Mitutoyo for more information.
*6: An adapter may be required when mounting any of these stages.
Consult Mitutoyo for more information.

Optional Accessories for VMU

Manual turret

Has 4-objective mounts and can be fixed in the desired position relative (inward, outward, etc.) to the mounting surface.

Installed on 378-707 VMU-V with optional objectives

Order No.	**378-707**	**378-717**
Observation method	Bright-field	
No. of objective mounts	4 (Reference hole)	4 (1 reference hole and 3 holes with centering and parfocal adjustment)
Mass	780 g	990 g

Focus unit A and B

Manual focus units for the VMU.
An optional stand (**378-730**) and XY stage (**378-020**) are provided to be used in combination.

Focus unit A mounted on VMU-V with an optional objective

	Focus unit A	Focus unit B
Order No.	**378-705**	**378-706**
Travel range	50 mm	
Coarse/fine feed	Coarse: 3.8 mm/rev., Fine: 0.1 mm/rev.	
Loading capacity	Approx. 17.4 kg	Approx. 17.7 kg
Mass	2.9 kg	2.7 kg

TV adapter unit

C-mount adapters for changing to a higher or lower magnification.

2X TV adapter unit

0.5X TV adapter unit

	2X TV adapter unit	0.5X TV adapter unit
Order No.	**378-703**	**378-704**
Magnification	2X	0.5X
Suitable camera	2/3 inch or smaller type	1/2 inch or smaller type
Mass	25 g	25 g

Power turret

Has 5 objective mounts and can be fixed in the desired position relative (inward, outward, etc.) to the mounting surface.

Console box

Installed on WIDE VMU with optional objectives

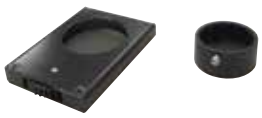
Order No.	**378-713**
Observation method	Bright-field
No. of objective mounts	5 (1 reference hole and 4 holes with centering adjustment
View field adjustment	±0.5 mm
Positioning accuracy	2 σ = 3 µm
Durability (life-time)	1 million repositioning operations
Drive method	DC motor
Power supply	AC100 V - 240 V, 10 W
Output interface	RS-232C *1 for external PC control
Cable length	2.9 m*2 (connection of power turret and console box)
Dimensions (WxHxD) and mass	Turret: 130x47x186 mm, 1.8 kg, Console box: 108x63x176 mm, 810 g

*1: Optional RS-232C Cable: **12AAA807**
*2: The length of cable connecting the power turret and console box is a safe maximum and therefore Mitutoyo does not guarantee error-free operation if a cable extension is used to increase total cable length.

Polarizer and Analyzer

Provides simplified polarized light observation. Also enhances contrast of low-magnification objectives.

No.378-710



No.378-715

Installed on VMU-L4B

Order No.	**378-710**	**VMU-V • VMU-H**
Order No.	**378-715**	**VMU-LB • VMU-L4B**

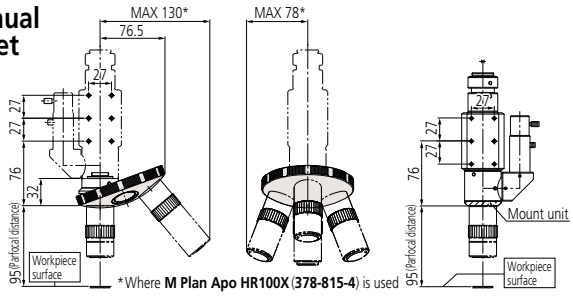
Camera mount

378-087

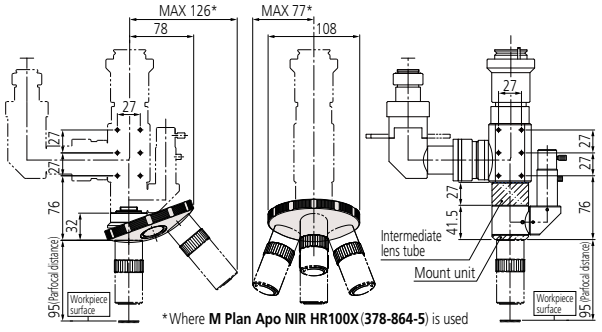
Can be attached to the laser mount (VMU-LB and VMU-L4B) for dual-camera system. It is compatible with 2/3 inch or smaller C-mount cameras.

Dimensions of Optional Accessories for VMU Series

Manual turret

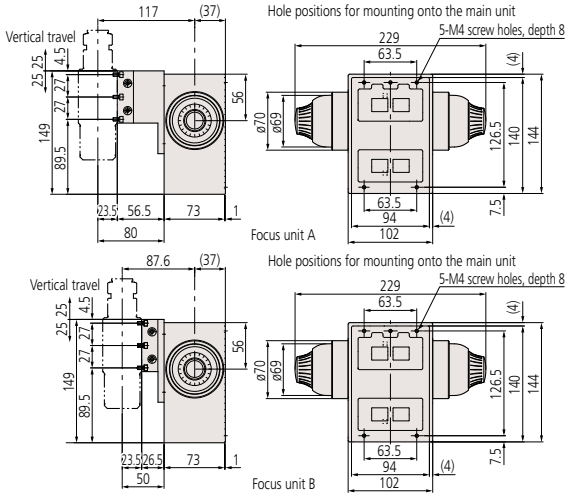


When mounting the turret on **VMU-V** or **VMU-H**
Note 1: The lens mount must be removed from VMU.
Note 2: The orientation of the revolver can be freely set to the mounting surface.

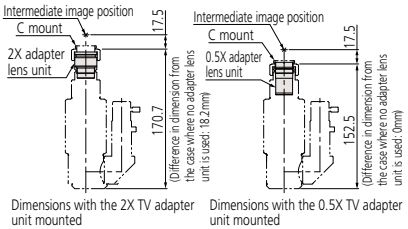


When mounting the turret on **VMU-LB** or **VMU-L4B**
Note 1: The middle optical tube and lens mount must be removed from VMU.
Note 2: The orientation of the revolver can be freely set to the mounting surface.

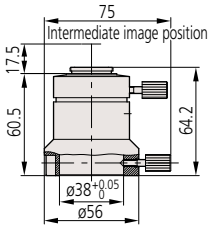
Focus unit A and B



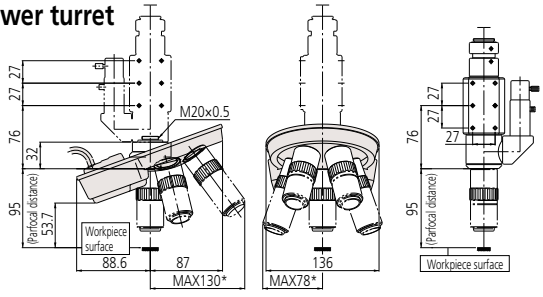
TV adapter unit



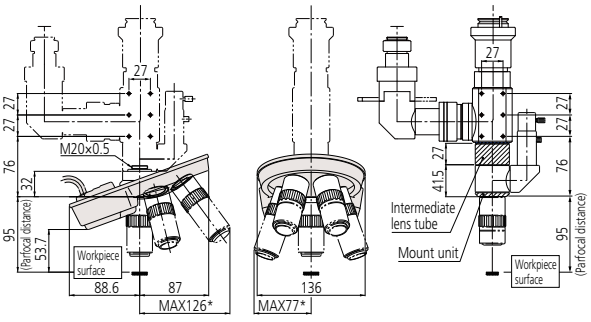
Camera mount



Power turret

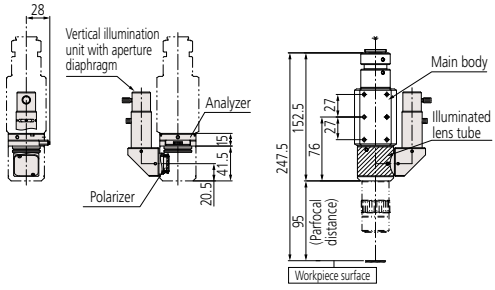


When mounting the turret on **VMU-V** or **VMU-H**
Note 1: The lens mount must be removed from VMU.
Note 2: The orientation of the revolver can be freely set to the mounting surface.

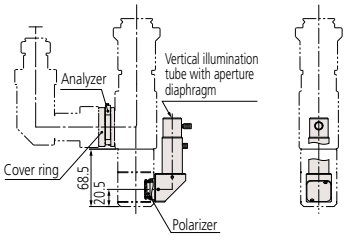


When mounting the turret on **VMU-LB** or **VMU-L4B**
Note 1: The middle optical tube and lens mount must be removed from VMU.
Note 2: The orientation of the revolver can be freely set to the mounting surface.

Polarizer and Analyzer



Installing the polarizer and analyzer on **VMU-V** or **VMU-H**
Note: The analyzer is installed by removing the Illuminated lens tube.
The polarizer is installed by removing the vertical illumination unit with aperture diaphragm.



When installing the polarizer on **VMU-LB** or **VMU-L4B**
Note: The analyzer is installed by loosening the cover ring.
The polarizer is installed by removing the vertical illumination unit with aperture diaphragm.

Mitutoyo

Wide field microscope unit for incorporating in equipment

WIDE VMU

WIDE VMU-V

WIDE VMU-H

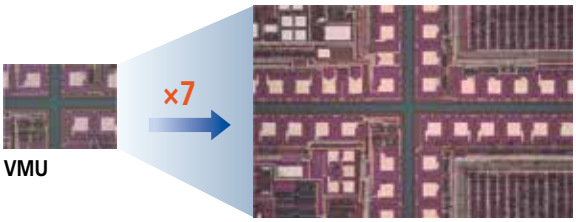
WIDE VMU-BDV

WIDE VMU-BDH

Objectives shown mounted on tubes are optional.

Features

- Designed for a wide-field image sensor (APS-C format or smaller size) providing seven times greater viewing area than the VMU Series for greatly enhanced inspection efficiency.

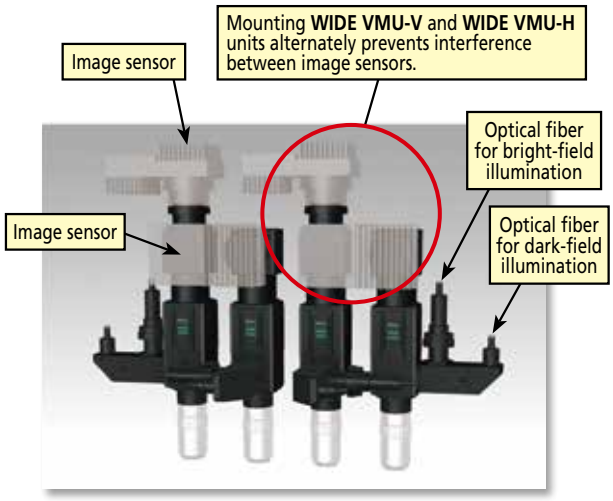


WIDE VMU

- In addition to normal bright-field observation, this series supports dark-field observation for scratch inspection, etc., and polarized light observation for increased contrast when viewing certain specimens.

WIDE VMU dark-field

- Bulk inspections covering a wide area can be performed with multiple units in a high-density configuration.

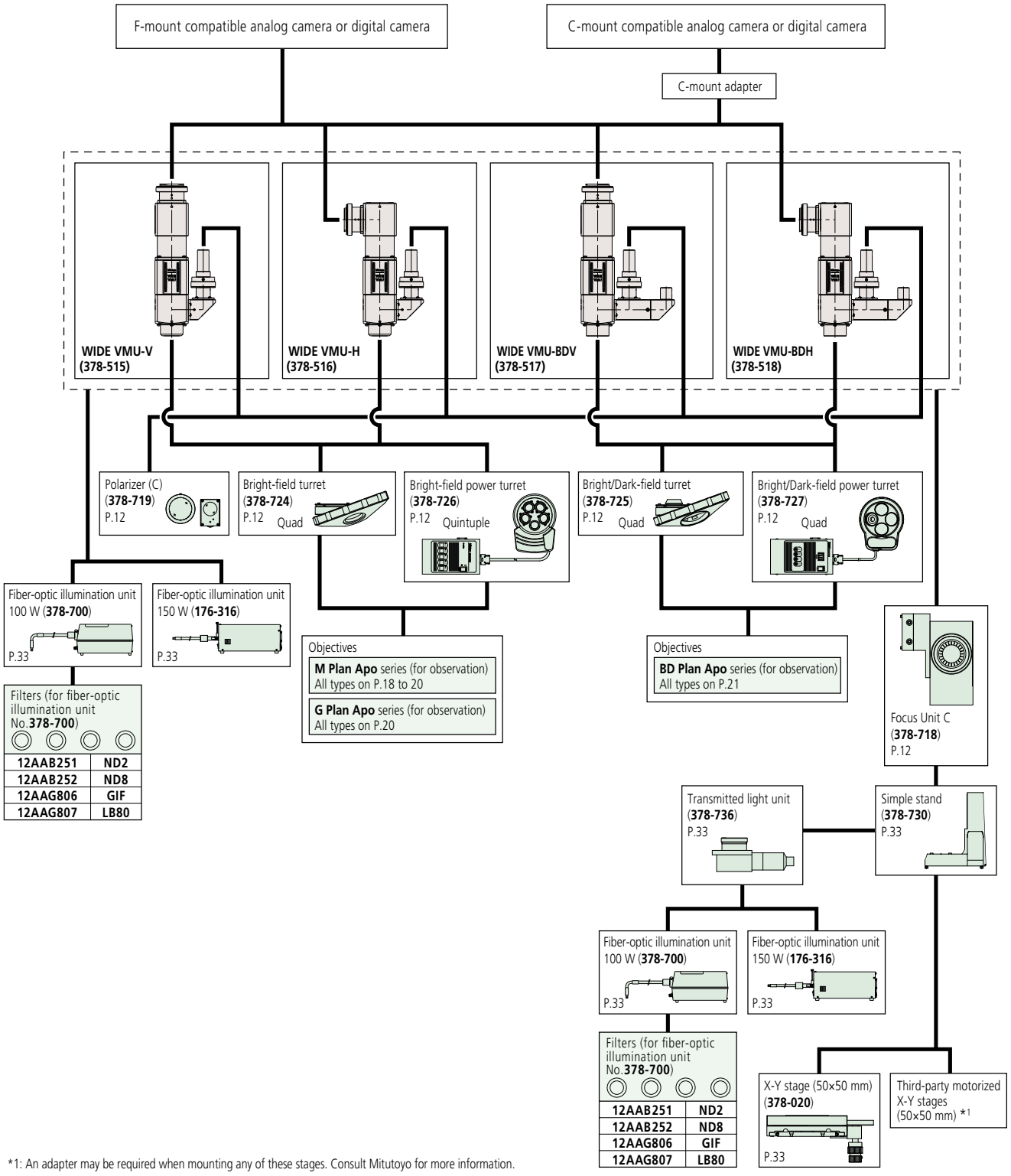


Specifications

		For Bright-field Observation		For Bright/Dark-field Observation	
Model No.		**WIDE VMU-V**	**WIDE VMU-H**	**WIDE VMU-BDV**	**WIDE VMU-BDH**
Order No.		**378-515**	**378-516**	**378-517**	**378-518**
Camera mounting orientation		Vertical	Horizontal	Vertical	Horizontal
Observation		Bright-field/Erect image	Bright-field/Inverted image	Bright/Dark-field/Erect image	Bright/Dark-field/Inverted image
Optical tube	Optical system	Magnification: 1X, visible light			
	Camera Mount	F-Mount, C-Mount (with aligning and parfocal adjustment mechanism)			
	Imaging forming (tube) lens	Built-in 1X tube lens (Correcting wavelength range: 436 - 656 nm)			
	Image field	ø30			
	Polarization unit*	Mountable			
Objective lens (required option)		**M Plan Apo, M Plan Apo HR, M Plan Apo SL, G Plan Apo**		**BD Plan Apo, BD Plan Apo HR, BD Plan Apo SL**	
Applicable camera		APS-C format or smaller size			
Reflected illumination optical system		Telecentric illumination, Bright-field illumination optical tube (Single-port fiber-optic illumination)		Telecentric illumination, Bright/Dark-field illumination optical tube (Dual-port fiber-optic illumination) Bright/Dark-field switching with light source on-off	
Illumination unit (optional)		Fiber-optic illumination unit (12 V, 100 W) (**No. 378-700**)/ (15 V, 150 W) (**No. 176-316**)			
Main unit mass		1800 g	1950 g	2000 g	2150 g

*Polarized observation by Bright-field illumination

System diagram



*1: An adapter may be required when mounting any of these stages. Consult Mitutoyo for more information.

Optional Accessories for WIDE VMU Series

Bright-field turret
Bright/Dark-field turret

Has 4-objective mounts and can be fixed in the desired position relative (inward, outward, etc.) to the mounting surface.

No.378-724

No.378-725

Installed on 378-724 WIDE VMU with optional objectives

Order No.	378-724	378-725
Observation method	Bright-field	Bright/Dark-field
No. of objective mounts	4 (Reference hole)	4 (Reference hole)
Mass	825 g	755 g
Applicable models	**WIDE VMU-V** **WIDE VMU-H**	**WIDE VMU-BDV** **WIDE VMU-BDH**

Focus unit C

Manual focus units for the WIDE VMU. When an optional stand (378-730) is mounted, center of stage and optical axis are matched.

Focus unit C mounted on -WIDE VMU with an optional objective

	Focus unit C
Order No.	**378-718**
Travel range	50 mm
Coarse/fine feed	Coarse: 3.8 mm/rev., Fine: 0.1 mm/rev.
Loading capacity	Approx. 17.4 kg
Mass	2.7 kg
Applicable models	**WIDE VMU** (all models)

Bright-field power turret
Bright/Dark-field power turret

Has 5-objective mounts for Bright-field power turret and 4-objective mounts for Bright/Dark-field power turret. It can be fixed in the desired position relative (inward, outward, etc.) to the mounting surface.

No.378-726

Installed on No.378-726 WIDE VMU with optional objectives

No.378-727

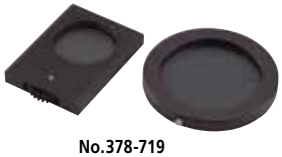
Order No.	378-726	378-727
Observation method	Bright-field	Bright/Dark-field
No. of objective mounts	5 (1 reference hole and 4 holes with centering adjustment)	4 (Reference hole)
View field adjustment	±0.5 mm	–
Positioning accuracy	2 σ = 3 µm	–
Durability (life-time)	1 million repositioning operations	–
Drive method	DC motor	–
Power supply	AC100 V - 240 V Max. power consumption is approx. 10 W	AC100 V - 240 V Max. power consumption is approx. 6 W
Output interface	RS-232C*1 for external PC control	
Cable length	2.9 m*2 (connection of power turret and console box)	
Dimension: W×H×D (mm) Mass	Turret: 130×47×186 mm, 1.8 kg, Console box: 108×63×176 mm, 810 g	Turret: 164×65×137 mm, 1.8 kg, Console box: 108×72×193 mm, 810 g
Applicable models	**WIDE VMU-V** **WIDE VMU-H**	**WIDE VMU-BDV** **WIDE VMU-BDH**

*1: Optional RS-232C Cable: **12AAA807**

*2: The length of cable connecting the power turret and console box is a safe maximum and therefore Mitutoyo does not guarantee error-free operation if a cable extension is used to increase total cable length.

Polarizer and Analyzer (C)

Provides simplified polarized light observation. Also enhances contrast of low-magnification objectives.

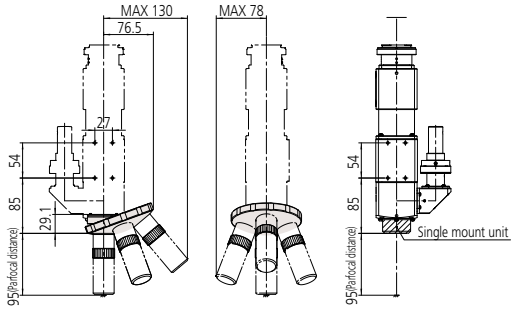


No.378-719

Order No.	378-719	**WIDE VMU** (all models)

Dimensions of Optional Accessories for WIDE VMU Series

Bright-field turret

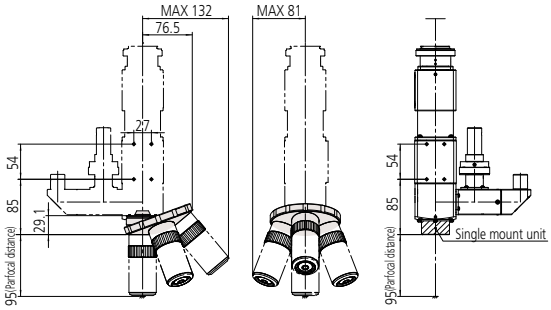


When mounting the turret on **WIDE VMU**

Note 1: Turret is installed by removing the single mount unit, but the distance between the mounting position of WIDE VMU main unit and the stage is unchanged.

Note 2: Turret mounting direction is limited to the direction indicated in the above figure.

Bright/Dark-field turret

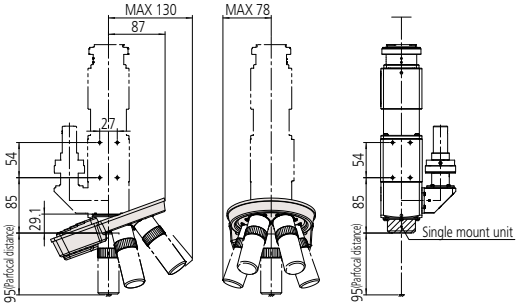


When mounting the turret on **WIDE VMU**

Note 1: Turret is installed by removing the single mount unit, but the distance between the mounting position of WIDE VMU main unit and the stage is unchanged.

Note 2: Turret mounting direction is limited to the direction indicated in the above figure.

Bright-field power turret

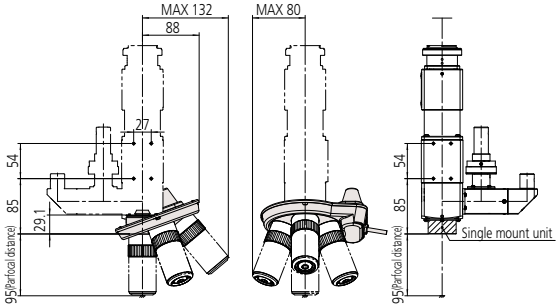


When mounting the turret on **WIDE VMU**

Note 1: Turret is installed by removing the single mount unit, but the distance between the mounting position of WIDE VMU main unit and the stage is unchanged.

Note 2: Turret mounting direction is limited to the direction indicated in the above figure.

Bright/Dark-field power turret

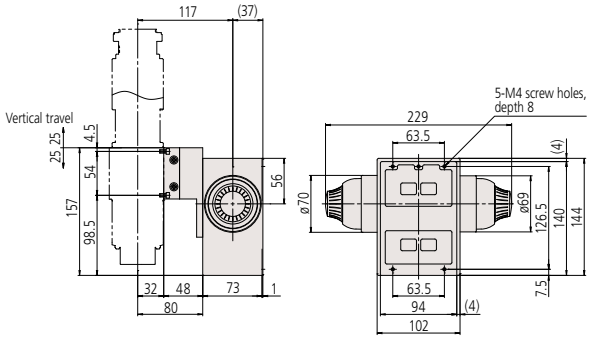


When mounting the turret on **WIDE VMU**

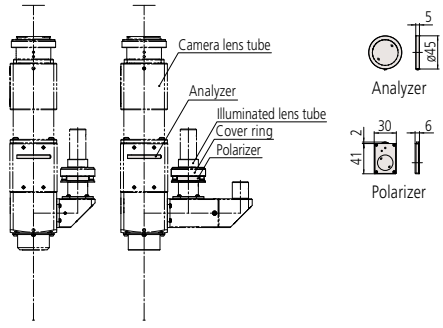
Note 1: Turret is installed by removing the single mount unit, but the distance between the mounting position of WIDE VMU main unit and the stage is unchanged.

Note 2: Turret mounting direction is limited to the direction indicated in the above figure.

Focus unit C



Polarizer and Analyzer (C)



When mounting the turret on **WIDE VMU**

Note: The polarizer is installed by loosening the cover ring. The analyzer is installed by removing the camera lens tube.

Mitutoyo

Finescope unit
FS70

FS70Z

FS70L4

Objectives and eyepieces shown mounted are optional.

Features

> Compact microscope unit with trinocular eyepiece tube.
Suitable for observation of many different types of objects: metal surfaces, semiconductors, LCDs, resins, etc.

> Can be used with YAG (near-infrared, visible, near-ultraviolet, or ultraviolet) lasers.[*1]
Suitable for cutting, trimming, repair and marking of IC wiring (Au, Al), removing and processing thin-films (insulating film) and repair of color filters (defects repair). Also ideal as the microscope unit of a prober station for semiconductor substrates.

> Compatible with infrared optical systems[*2]**.**
Available for inner observation of silicon package and spectral characteristics analysis by using infrared light source and camera.

> Available for various observations in bright-field, dark-field*, simplified polarized and differential interference contrast (DIC).
*Made-to-order

> Telecentric reflective illumination system with aperture diaphragm.

> High operability due to the inward turret design and long-working-distance objectives.

*1: The performance and safety of laser-equipped system products is not guaranteed.
*2: An infrared source and infrared camera are necessary.

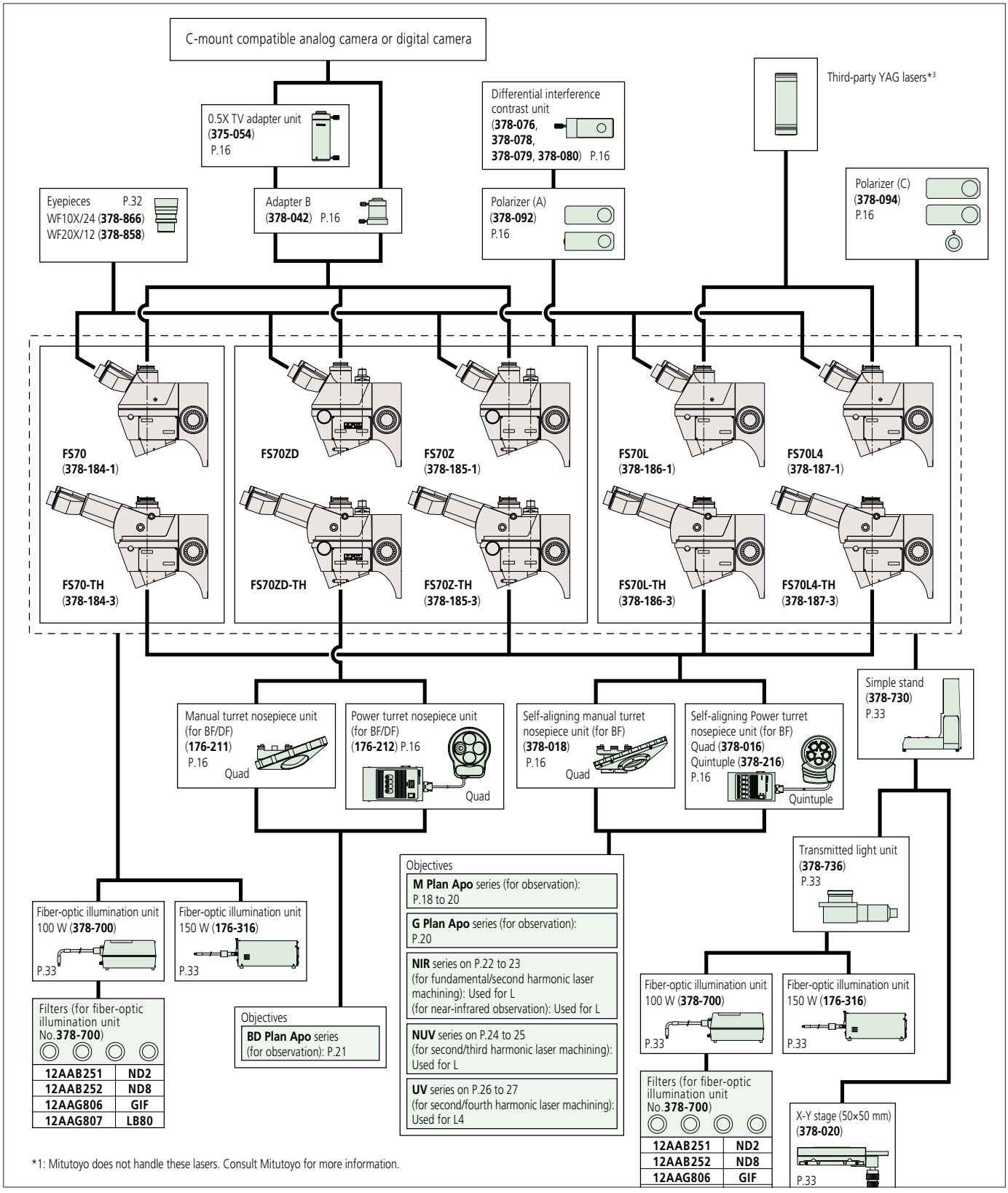
Specifications

Standard head type	Model No.	**FS70**	—	**FS70Z**	—	**FS70ZD**	**FS70L**	**FS70L4**
	Order No.	**378-184-1**	—	**378-185-1**	—	Made-to-order	**378-186-1**	**378-187-1**
Tilting head type	Model No.	—	**FS70-TH**	—	**FS70Z-TH**	**FS70ZD-TH**	**FS70L-TH**	**FS70L4-TH**
	Order No.	—	**378-184-3**	—	**378-185-3**	Made-to-order	**378-186-3**	**378-187-3**
Focus adjustment		50 mm travel range with concentric coarse (3.8 mm/rev) and fine (0.1 mm/rev) focusing wheels (right / left)						
Observation image		Erect image						
	BF (Bright-field)	✓	✓	✓	✓		✓	✓
	BD (Bright-field/ Dark-field)					✓		
	Polarization	✓	✓	✓	✓	✓	✓	✓
	Differential interference contrast (DIC)	✓	✓	✓	✓	✓		
Optical tube type		Siedentopf, adjustable interpupillary distance range: 51 - 76 mm						
Field number		24 mm						
Tilt angle		0 to 20°, displacement of eye point: 114 mm (only for tilting head type)						
Optical pass ratio		Fixed type (Eyepiece/TV = 50/50)	Switchable type (Eyepiece/Tube = 100/0: 0/100)	Fixed type (Eyepiece/TV = 50/50)	Switchable type (Eyepiece/Tube = 100/0: 0/100)	Fixed type *3 (Eyepiece/TV = 50/50)	Switchable type (Eyepiece/Tube = 100/0: 0/100)	
Protective filter		—					Built-in laser beam filter	
Tube lens		1X		1X - 2X zoom			1X	
Applicable laser		—					1064/532/355 nm	532/266 nm
Camera mount		C-mount (using optional adapter B*1)					Use a laser with TV port.	C-mount receptacle (with green filter switch)
Illumination system, optional		Reflective illumination for Bright-field (Koehler illumination, with aperture diaphragm) 12 V, 100 W fiber-optics, stepless adjustment, light guide length: 1.5 m						
Objective, optional (for observation)		**M Plan Apo/HR/SL, G Plan Apo**				**BD Plan Apo**	**M Plan Apo/HR/SL, G Plan Apo**	
Objective, optional (for laser-cutting)		—				**NIR Series NUV Series**		**UV Series**
Loading *2		14.5 kg	13.6 kg	14.1 kg	13.2 kg	14.1 kg (tilting head type: 13.2 kg)	14.2 kg (tilting head type: 13.5 kg)	13.9 kg (tilting head type: 13.1 kg)
Mass (main unit)		6.1 kg	7.1 kg	6.6 kg	7.5 kg	6.6 kg (tilting head type: 7.5 kg)	6.4 kg (tilting head type: 7.2 kg)	6.7 kg (tilting head type: 7.5 kg)

*1: Installation is optional. *2: Loading on optical tube excluding weight of objective lenses and eyepieces
*3: It is a switchable type when using FS70ZD-TH (Tilting head type).

Note: Observe the following precautions when using FS70L or FS70L4 with YAG laser source attached.
· Be aware of the laser power and energy density limitations of the optical system to avoid damaged.
· Check the mass of the laser source. When mounting on a high-speed device or acceleration/deceleration device, please contact us.

System diagram



*1: Mitutoyo does not handle these lasers. Consult Mitutoyo for more information.

Optional Accessories for FS70

Manual turret

Order No.	378-018	378-211
Observation method	Bright-field	Bright/Dark-field
No. of objective mounts	4 (1 reference hole and 3 holes with centering and parfocal adjustment)	4
View field adjustment	±0.5 mm	—
Parfocal adjustment	±0.5 mm	—
Mass	980 g	1.2 kg

Polarizer and analyzer

For simplified polarized-light observation. Also suitable for enhancing contrast of low-magnification objectives.

For **FS70Z**
378-092

For **FS70L • FS70L4**
378-094

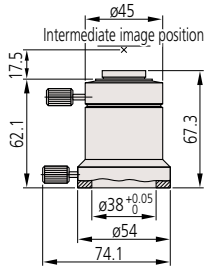
DIC unit

Used for differential interference contrast observation in conjunction with the polarizer.

Order No.	Magnification
378-076	100X, SL80X, SL50X
378-078	50X, SL20X
378-079	20X
378-080	10X, 5X

Adapter B

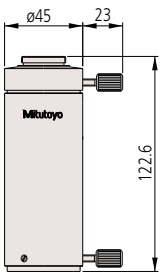
Used for mounting a C-mount camera.



378-042
View field of image: ø11 mm
Mass: 170 g

0.5X TV adapter unit

Allows observation over a wide field of view on the monitor (2X wide) due to the 0.5X relay optics.
It is used in conjunction with the optional adapter B.



378-054
View field of image: ø11 mm
Mass: 300 g

Power turret

378-016

Console box

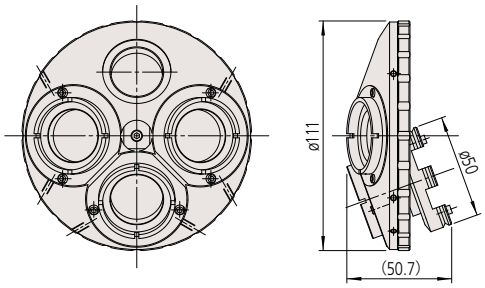
Order No.	378-216	378-016	176-212
Observation method	Bright-field		Bright/Dark-field
No. of objective mounts	5 (1 reference hole and 4 holes with centering adjustment)	4 (1 reference hole and 3 holes with centering adjustment)	4
View field adjustment	±0.5 mm		—
Positioning accuracy	2 σ = 3 µm	—	—
Durability (life-time)	1 million repositioning operations	—	—
Drive method	DC motor		
Power supply	AC100 V - 240 V, 10 W	AC100 V - 240 V, 6 W	
Output interface	RS-232C*1 for external PC control		
Cable length	2.9 m*2 (connection of power turret and console box)		
Dimensions (WxHxD) and mass	Turret: 164x65x137 mm, 1.4 kg (**378-216**: 130x47x186 mm, 1.7 kg) Console box: 108x72x193 mm, 810 g (**378-216**: 108x63x176 mm, 810 g)		

*1: Optional RS-232C Cable: **12AAA807**
*2: The length of cable connecting the power turret and console box is a safe maximum and therefore Mitutoyo does not guarantee error-free operation if a cable extension is used to increase total cable length.

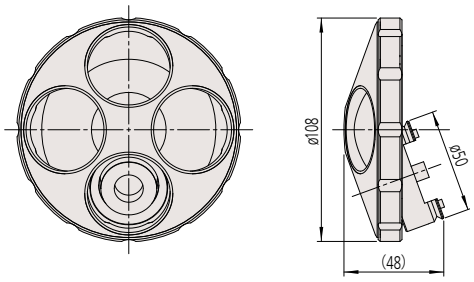
Dimensions of Optional Accessories for FS70

Manual turret

378-018

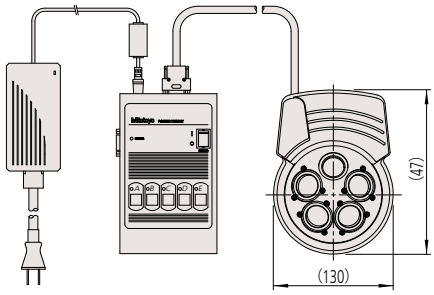


176-211

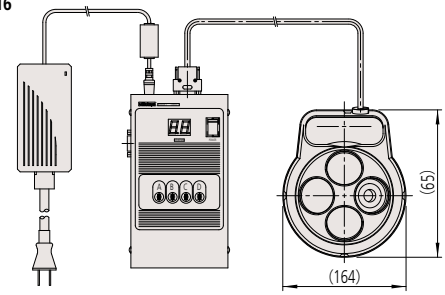


Power turret

378-216



176-212/378-016



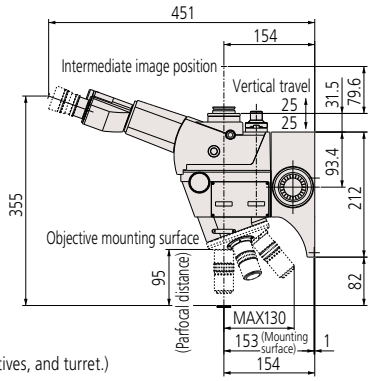
Optional objective adapter: 378-026-1

This objective adapter allows mounting the bright-field objective on the bright/dark-field turret (**176-211** and **176-210**) while maintaining the focus position (parfocal).

Order No.	**378-026-1**
Applicable models	Microscopes mounted with the bright/dark-field manual turret or power turret **(MF-U, HyperMF-U)**
Applicable objective lens	**M Plan Apo, M Plan Apo SL, G Plan Apo, M Plan Apo NIR, M Plan Apo NUV, M Plan UV**

Tilting head type

Mitutoyo's FS70-series lineup adopts a tilting head specification that allows the user to adjust the head to an appropriate eye point according to personal physical attributes when looking through the microscope eyepiece.



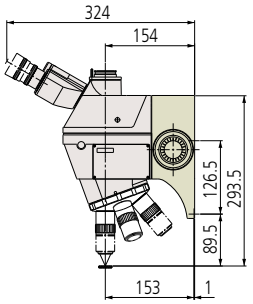
FS70Z-TH
(FS70Z-TH with optional eyepieces, objectives, and turret.)

Focus point adjust shim set

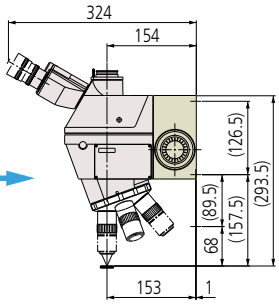
Order No.	Use	Details
378-089	For bright-field turret	The focus point adjust shim set includes 50 µm, 30 µm and 20 µm thickness SUS rings
378-090	For bright/dark-field turret	

Short focus unit type

Manual Focus Unit S can be mounted on the main unit 68 mm higher than the standard focus unit without changing the eye-point position. The order numbers in the following table represent the FS70-series main units on which this focus unit has previously been mounted.



Standard Focus Unit mounting dimensions



Manual Focus Unit S mounting dimensions

Model	**FS70-S**	**FS70Z-S**	**FS70L-S**	**FS70L4-S**
Order No.	**378-184-2**	**378-185-2**	**378-186-2**	**378-187-2**
Travel range	50 mm			
Coarse/fine feed	Coarse feed: 3.8 mm/rev., Fine feed: 0.1 mm/rev.			
Loading capacity of camera mount*	14.5 kg	14.1 kg	14.2 kg	13.9 kg
Mass	6.1 kg	6.6 kg	6.4 kg	6.7 kg

*Mass of turret, objective, and eyepiece are excluded.
Note: If the tilting head type with a short focus unit is required, please contact your local Mitutoyo sales office.

Objectives for Bright-field Observation (long working distance)

M Plan Apo / M Plan Apo HR

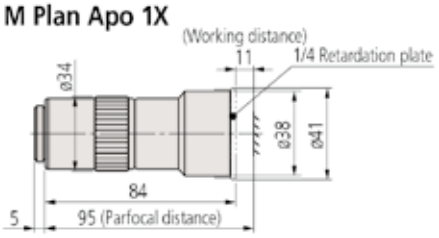
VMU | WIDE VMU | FS70 | MF-U | Hyper MF-U

Features

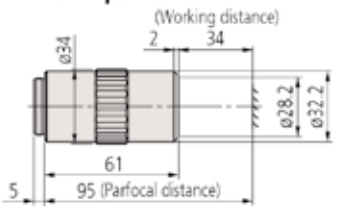
> Infinity corrected
> Bright-field observation
> Long working distance
> Plan-Apochromat

Dimensions

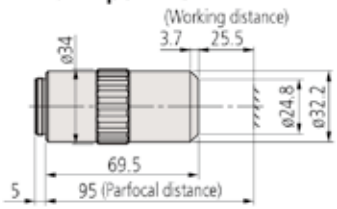
M Plan Apo 1X



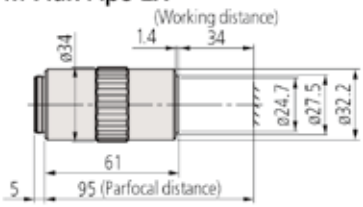
M Plan Apo 10X



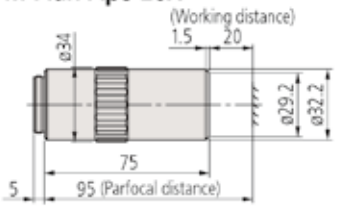
M Plan Apo HR 5X



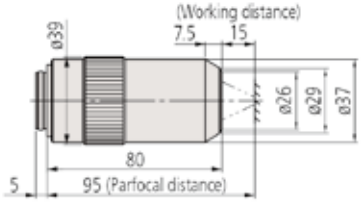
M Plan Apo 2X



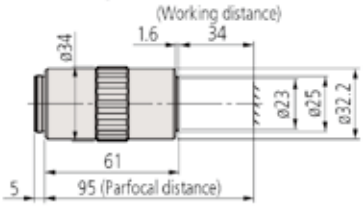
M Plan Apo 20X



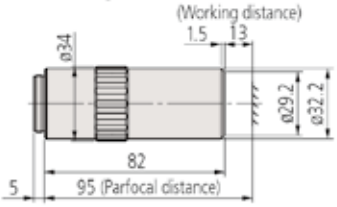
M Plan Apo HR 10X



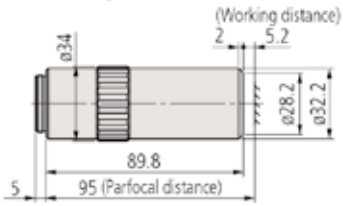
M Plan Apo 5X



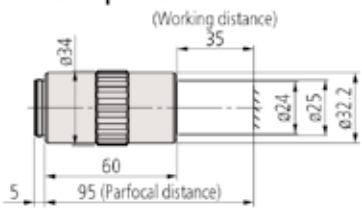
M Plan Apo 50X



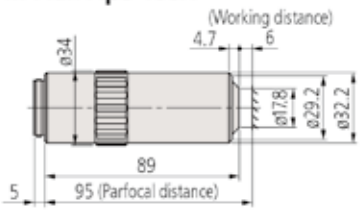
M Plan Apo HR 50X



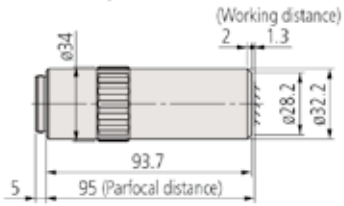
M Plan Apo 7.5X



M Plan Apo 100X



M Plan Apo HR 100X



Specifications

Model	Order No.	N.A.	W.D. (mm)	f (mm) (λ = 550 nm)	R (μm) (λ = 550 nm)	±DOF (μm)	Real FOV (mm)		Mass (g)
							ø24 eyepiece	1/2 inch camera	
M Plan Apo									
M Plan Apo 1X *1	**378-800-12**	0.025	11.0	200	11.0	440	24	4.8×6.4	300
M Plan Apo 2X *2	**378-801-12**	0.055	34.0	100	5.0	91	12	2.4×3.2	220
M Plan Apo 5X	**378-802-6**	0.14	34.0	40	2.0	14	4.8	0.96×1.28	230
M Plan Apo 7.5X	**378-807-3**	0.21	35.0	26.67	1.3	6.2	3.2	0.64×0.85	240
M Plan Apo 10X	**378-803-3**	0.28	34.0	20	1.0	3.5	2.4	0.48×0.64	240
M Plan Apo 20X	**378-804-3**	0.42	20.0	10	0.7	1.6	1.2	0.24×0.32	270
M Plan Apo 50X	**378-805-3**	0.55	13.0	4	0.5	0.9	0.48	0.10×0.13	290
M Plan Apo 100X	**378-806-3**	0.70	6.0	2	0.4	0.6	0.24	0.05×0.06	320
M Plan Apo HR									
M Plan Apo HR 5X *3	**378-787-4**	0.21	25.5	40	1.3	6.2	4.8	0.96×1.28	285
M Plan Apo HR 10X *3	**378-788-4**	0.42	15.0	20	0.7	1.60	2.4	0.48×0.64	460
M Plan Apo HR 50X	**378-814-4**	0.75	5.2	4	0.4	0.49	0.48	0.10×0.13	400
M Plan Apo HR 100X	**378-815-4**	0.90	1.3	2	0.3	0.34	0.24	0.05×0.06	410

• Every resolution and single objective's depth of focus in the above table is a value determined on the basis of a reference wavelength (λ = 550 nm).
*1: When observing a workpiece whose optical reflectance is low, an appropriate polarizer should be used with this lens.
*2: When observing a workpiece whose optical reflectance is low, using this lens with a 1/4 wave plate and polarization unit (No.02ALN370) is recommended.
*3: These specifications apply to the objectives in isolation and may not apply when a lens is mounted in the turret of a microscope, depending on the design of that microscope.
In the case where the illumination system is provided by the user it is important to balance the various optical parameters so that optimum illumination of the target surface is obtained.
Contact your local Mitutoyo Sales Office for information on how this may be achieved.
Made-to-order

Objectives for Bright-field Observation (super long working distance)

M Plan Apo SL

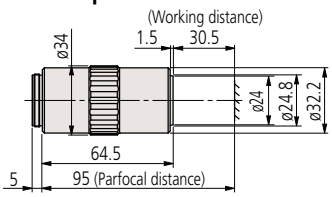
VMU | WIDE VMU | FS70 | MF-U | Hyper MF-U

Features

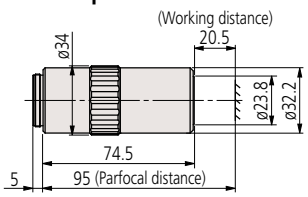
> Infinity corrected
> Bright-field observation
> Super long working distance
> Plan-Apochromat

Dimensions

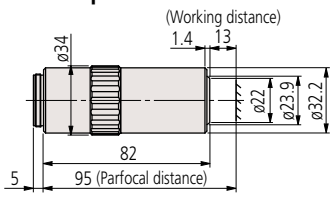
M Plan Apo SL20X



M Plan Apo SL50X



M Plan Apo SL100X



Specifications

Model	Order No.	N.A.	W.D. (mm)	f (mm) (λ=550 nm)	R (μm) (λ=550 nm)	±DOF (μm)	Real FOV (mm)		Mass (g)
							ø24 eyepiece	1/2 inch camera	
M Plan Apo SL									
M Plan Apo SL20X	**378-810-3**	0.28	30.5	10	1.0	3.5	1.2	0.24×0.32	240
M Plan Apo SL50X	**378-811-15**	0.42	20.5	4	0.7	1.6	0.48	0.10×0.13	280
M Plan Apo SL100X	**378-813-3**	0.55	13.0	2	0.5	0.9	0.24	0.05×0.06	290

• Every resolution and single objective's depth of focus in the above table is a value determined on the basis of a reference wavelength (λ=550 nm).

Objectives for Bright-field Observation (with cover-glass thickness compensation)

G Plan Apo

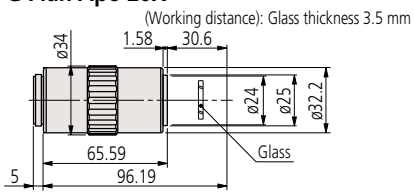
VMU | WIDE VMU | FS70 | MF-U | Hyper MF-U

Features

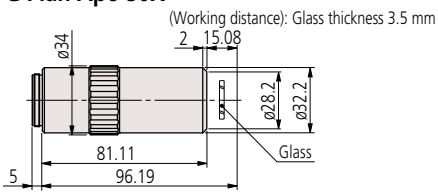
> Infinity corrected
> Bright-field observation
> Super long working distance
> Plan-Apochromat
> Designed to observe a specimen through a 3.5 mm cover glass.
> Design enables high-power observation through a cover glass.
Note: Contact Mitutoyo to custom-order a specific cover-glass to suit your application if required. Thickness, material and refractive index are all specifiable within usual limits.

Dimensions

G Plan Apo 20X



G Plan Apo 50X



Specifications

Model	Order No.	N.A.	W.D. (mm)	f (mm) (λ=550 nm)	R (μm) (λ=550 nm)	±DOF (μm)	Real FOV (mm)		Mass (g)
							ø24 eyepiece	1/2 inch camera	
G Plan Apo									
G Plan Apo 20X (t3.5)	**378-847**	0.28	29.42*	10	1.0	3.5	1.2	0.24×0.32	270
G Plan Apo 50X (t3.5)	**378-848-3**	0.50	13.89*	4	0.6	1.1	0.48	0.10×0.13	320

• Every resolution and single objective's depth of focus in the above table is a value determined on the basis of a reference wavelength (λ=550 nm).
* In air

Objectives for Bright/Dark-field Observation (long working distance)

BD Plan Apo

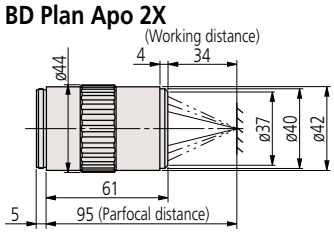
FS70 WIDE VMU MF-U Hyper MF-U

Features

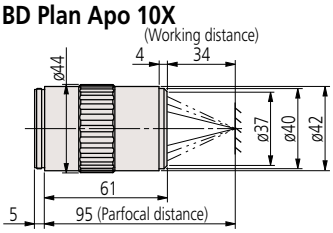
> Infinity corrected
> Bright/dark-field observation
Suited to the observation of scratches, concavity and convexity on a surface
> Long working distance
> Plan-Apochromat

Dimensions

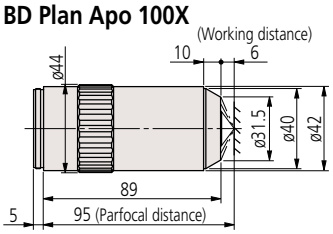
BD Plan Apo 2X



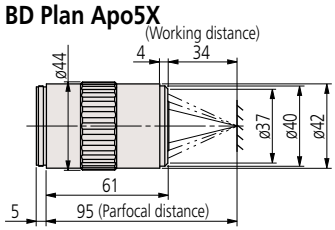
BD Plan Apo 10X



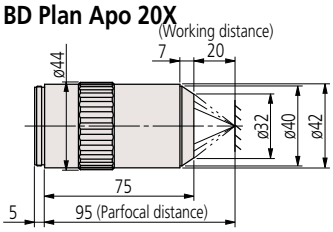
BD Plan Apo 100X



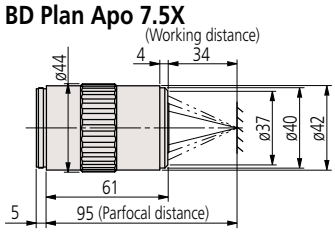
BD Plan Apo5X



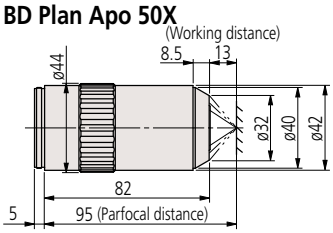
BD Plan Apo 20X



BD Plan Apo 7.5X



BD Plan Apo 50X



Specifications

Model	Order No.	N.A.	W.D. (mm)	f (mm) (λ=550 nm)	R (μm) (λ=550 nm)	±DOF (μm)	Real FOV (mm)		Mass (g)
							ø24 eyepiece	1/2 inch camera	
BD Plan Apo									
BD Plan Apo 2X*	**378-831-12**	0.055	34.0	100	5.0	91	12	2.4×3.2	340
BD Plan Apo 5X	**378-832-7**	0.14	34.0	40	2.0	14	4.8	0.96×1.28	350
BD Plan Apo 7.5X	**378-830-7**	0.21	34.0	26.67	1.3	6.2	3.2	0.64×0.85	350
BD Plan Apo 10X	**378-833-7**	0.28	34.0	20	1.0	3.5	2.4	0.48×0.64	350
BD Plan Apo 20X	**378-834-7**	0.42	20.0	10	0.7	1.6	1.2	0.24×0.32	400
BD Plan Apo 50X	**378-835-7**	0.55	13.0	4	0.5	0.9	0.48	0.10×0.13	440
BD Plan Apo 100X	**378-836-7**	0.70	6.0	2	0.4	0.6	0.24	0.05×0.06	460

• Every resolution and single objective's depth of focus in the above table is a value determined on the basis of a reference wavelength (λ=550 nm).
* It is recommended to be used together with the 1/4 wavelength plate B (02ALN380) and appropriate polarizer for the microscope used (Working distance will be shortened 4 mm).

Mitutoyo

Near-infrared radiation range objectives for Bright-field observation

M Plan Apo NIR / M Plan Apo NIR HR / M Plan Apo NIR B

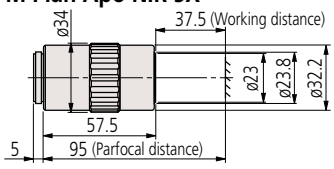
VMU FS70

Features

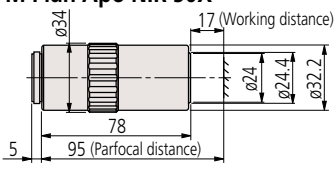
> Infinity corrected
> Suitable for bright-field observation and laser applications
> Long working distance
> Plan-Apochromat
> Wavelength correction from visible to near-infrared (1800 nm)
> Available high-power type (M Plan Apo NIR HR)

Dimensions

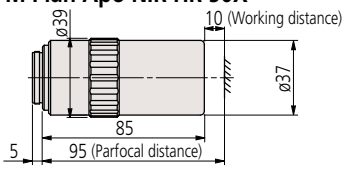
M Plan Apo NIR 5X



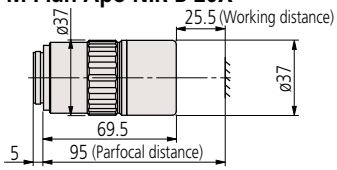
M Plan Apo NIR 50X



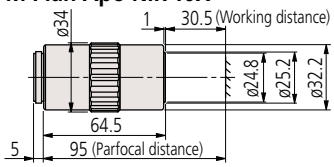
M Plan Apo NIR HR 50X



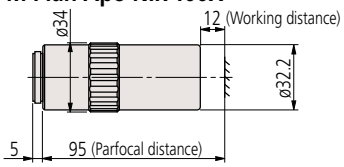
M Plan Apo NIR B 20X



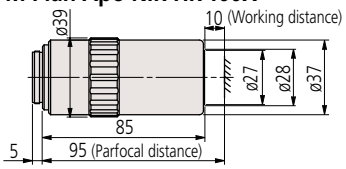
M Plan Apo NIR 10X



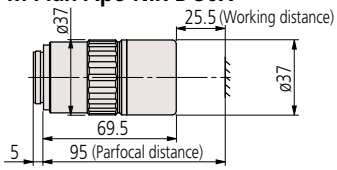
M Plan Apo NIR 100X



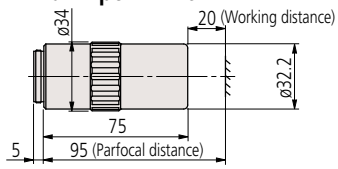
M Plan Apo NIR HR 100X



M Plan Apo NIR B 50X



M Plan Apo NIR 20X



Specifications

Model	Order No.	N.A.	W.D. (mm)	f (mm) (λ=550 nm)	R (μm) (λ=550 nm)	±DOF (μm)	Real FOV (mm)		Mass (g)
							ø24 eyepiece	1/2 inch camera	
M Plan Apo NIR									
M Plan Apo NIR 5X	**378-822-5**	0.14	37.5	40	2.0	14.0	4.8	0.96×1.28	220
M Plan Apo NIR 10X	**378-823-5**	0.26	30.5	20	1.1	4.1	2.4	0.48×0.64	250
M Plan Apo NIR 20X	**378-824-5**	0.40	20.0	10	0.7	1.7	1.2	0.24×0.32	300
M Plan Apo NIR 50X	**378-825-5**	0.42	17.0	4	0.7	1.6	0.48	0.10×0.13	315
M Plan Apo NIR 100X	**378-826-15**	0.50	12.0	2	0.6	1.1	0.24	0.05×0.06	335
M Plan Apo NIR HR									
M Plan Apo NIR HR 50X	**378-863-5**	0.65	10.0	4	0.4	0.7	0.48	0.10×0.13	450
M Plan Apo NIR HR 100X	**378-864-5**	0.70	10.0	2	0.4	0.6	0.24	0.05×0.06	450
M Plan Apo NIR B									
M Plan Apo NIR B 20X	**378-867-5**	0.40	25.5	10	0.7	1.7	1.2	0.24×0.13	350
M Plan Apo NIR B 50X	**378-868-5**	0.42	25.5	4	0.7	1.6	0.48	0.10×0.13	375

• Every resolution and single objective's depth of focus in the above table is a value determined on the basis of a reference wavelength (λ=550 nm).
Note: If the wavelength used is 1100 nm or longer, the focal point may deviate slightly from that in visible radiation.

Near-infrared radiation range objectives for Bright-field observation (with cover-glass thickness compensation)

LCD Plan Apo NIR / LCD Plan Apo NIR HR

VMU FS70

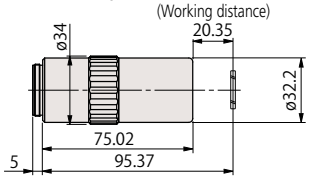
Features

> Infinity corrected
> Suitable for bright-field observation and laser-based repair applications through LCD glass
> Ultra-long working distance
> Plan-Apochromat
> Designed to observe a specimen through glass 1.1 mm or 0.7 mm thick.
> This makes these lenses suitable for high-power observation through a sheet of glass.

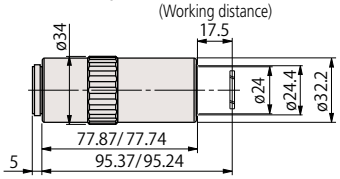
Note: Mitutoyo is ready to design and manufacture a specific sheet of glass according to a specified glass thickness and material (or refractive index).

Dimensions

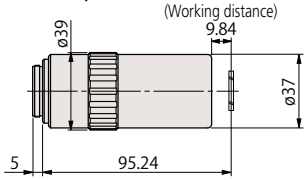
LCD Plan Apo NIR 20X (t1.1)



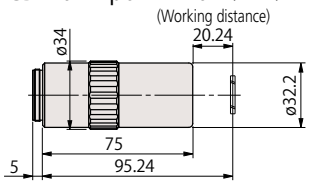
LCD Plan Apo NIR 50X (t1.1)/(t0.7)



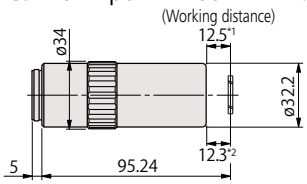
LCD Plan Apo NIR HR 50X (t0.7)



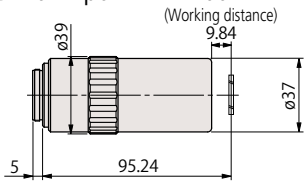
LCD Plan Apo NIR 20X (t0.7)



LCD Plan Apo NIR 100X (t1.1*1)/(t0.7*2)



LCD Plan Apo NIR HR 100X (t0.7)



Specifications

Model	Order No.	N.A.	W.D. (mm)	f (mm) (λ=550 nm)	R (μm) (λ=550 nm)	±DOF (μm)	Real FOV (mm)		Mass (g)
							ø24 eyepiece	1/2 inch camera	
LCD Plan Apo NIR									
LCD Plan Apo NIR 20X (t1.1)	**378-827-16**	0.40	19.98 *	10	0.7	1.7	1.2	0.24×0.32	305
LCD Plan Apo NIR 20X (t0.7)	**378-821-16**	0.40	20.00 *	10	0.7	1.7	1.2	0.24×0.32	305
LCD Plan Apo NIR 50X (t1.1)	**378-828-16**	0.42	17.13 *	4	0.7	1.6	0.48	0.10×0.13	320
LCD Plan Apo NIR 50X (t0.7)	**378-829-16**	0.42	17.26 *	4	0.7	1.6	0.48	0.10×0.13	320
LCD Plan Apo NIR 100X (t1.1)	**378-752-15**	0.5	12.13 *	2	0.6	1.1	0.24	0.05x0x06	335
LCD Plan Apo NIR 100X (t0.7)	**378-754-15**	0.50	12.06 *	2	0.6	1.1	0.24	0.05×0.06	335
LCD Plan Apo NIR HR									
LCD Plan Apo NIR HR 50X (t0.7)	**378-869-5**	0.65	9.6 *	4	0.4	0.7	0.48	0.10×0.13	450
LCD Plan Apo NIR HR 100X (t0.7)	**378-870-5**	0.70	9.6 *	2	0.4	0.7	0.24	0.05×0.06	450

• Every resolution and single objective's depth of focus in the above table is a value determined on the basis of a reference wavelength (λ=550 nm).
* In air

Mitutoyo

Near-ultraviolet radiation range objectives for Bright-field observation

M Plan Apo NUV / M Plan Apo NUV HR

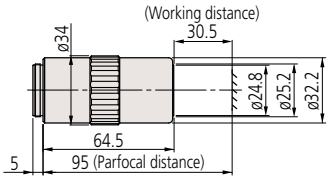
VMU FS70

Features

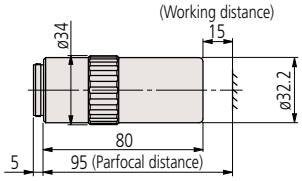
> Infinity corrected
> Suitable for bright-field observation and laser applications
> Long working distance
> Plan-Apochromat
> Performance optimized for near-ultraviolet (355 nm) to visible
> High-power type available (M Plan Apo NUV HR)

Dimensions

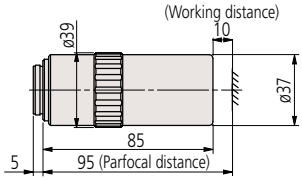
M Plan Apo NUV 10X



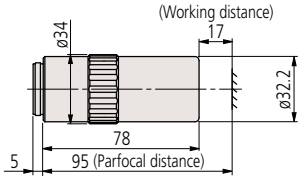
M Plan Apo NUV 50X



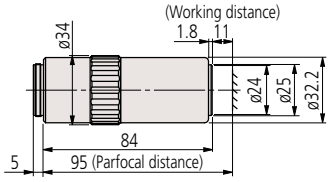
M Plan Apo NUV HR 50X



M Plan Apo NUV 20X



M Plan Apo NUV 100X



Specifications

Model	Order No.	N.A.	W.D. (mm)	f (mm) (λ=550 nm)	R (μm) (λ=550 nm)	±DOF (μm)	Real FOV (mm)		Mass (g)
							ø24 eyepiece	1/2 inch camera	
M Plan Apo NUV									
M Plan Apo NUV 10X	**378-809-5**	0.28	30.5	20	1	3.5	2.4	0.48×0.64	255
M Plan Apo NUV 20X	**378-817-8**	0.42	17.0	10	0.7	1.6	1.2	0.24×0.32	340
M Plan Apo NUV 50X	**378-818-8**	0.44	15.0	4	0.6	1.4	0.48	0.10×0.13	350
M Plan Apo NUV 100X	**378-819-4**	0.50	11.0	2	0.6	1.1	0.24	0.05×0.06	380
M Plan Apo NUV HR									
M Plan Apo NUV HR 50X	**378-888-6**	0.65	10.0	4	0.42	0.65	0.48	0.10×0.13	500

• Every resolution and single objective's depth of focus in the above table is a value determined on the basis of a reference wavelength (λ=550 nm).

Near-ultraviolet radiation range objectives for Bright-field observation (with cover-glass thickness compensation)

LCD Plan Apo NUV / LCD Plan Apo NUV HR

VMU FS70

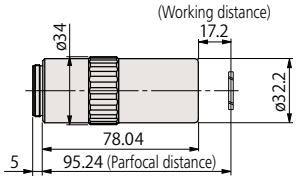
Features

> Infinity corrected
> Suitable for bright-field observation and laser-based repair applications through LCD glass
> Long working distance
> Plan-Apochromat
> Designed to observe a specimen through glass 1.1 mm or 0.7 mm thick.
> This makes these lenses suitable for high-power observation through a sheet of glass.

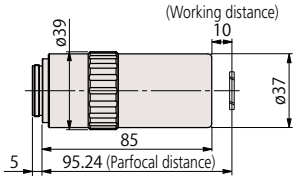
Note: Mitutoyo is ready to design and manufacture a specific sheet of glass according to a specified glass thickness and material (or refractive index).

Dimensions

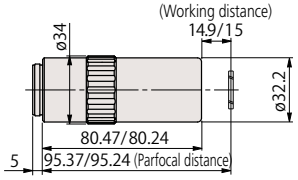
LCD Plan Apo NUV 20X (t0.7)



LCD Plan Apo NUV HR 50X (t0.7)



LCD Plan Apo NUV 50X (t0.7)



Specifications

Model	Order No.	N.A.	W.D. (mm)	f (mm) (λ=550 nm)	R (µm) (λ=550 nm)	±DOF (µm)	Real FOV (mm)		Mass (g)
							ø24 eyepiece	1/2 inch camera	
LCD Plan Apo NUV									
LCD Plan Apo NUV 20X (t0.7)	**378-890-8**	0.42	16.96 *	10	0.7	1.6	1.2	0.24×0.32	340
LCD Plan Apo NUV 50X (t0.7)	**378-820-8**	0.44	14.76 *	4	0.6	1.4	0.48	0.10×0.13	350
LCD Plan Apo NUV HR									
LCD Plan Apo NUV HR 50X (t0.7)	**378-891-6**	0.65	9.76 *	4	0.4	0.7	0.48	0.10×0.13	500

• Every resolution and single objective's depth of focus in the above table is a value determined on the basis of a reference wavelength (λ=550 nm).
* In air

Ultraviolet radiation range objectives for Bright-field observation

M Plan UV

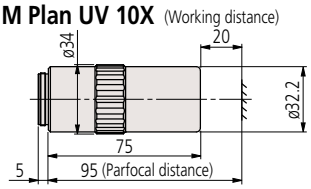
VMU FS70

Features

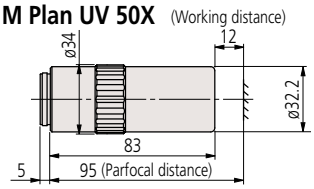
> Infinity corrected
> Suitable for bright-field observation and laser applications
> Long working distance
> Plan
> Performance optimized for ultraviolet (266 nm) and visible wavelengths
> High-transmittance in the ultraviolet range

Dimensions

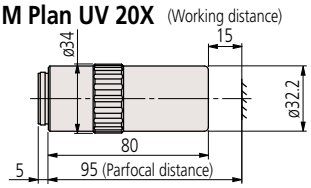
M Plan UV 10X (Working distance)



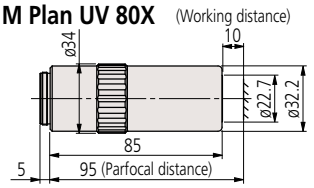
M Plan UV 50X (Working distance)



M Plan UV 20X (Working distance)



M Plan UV 80X (Working distance)



Specifications

Model	Order No.	N.A.	W.D. (mm)	f (mm)		R (μm) (λ=550 nm)	±DOF (μm)	Real FOV (mm)		Mass (g)
				f_{266}	f_{550}			ø24 eyepiece	1/2 inch camera	
M Plan UV										
M Plan UV 10X	**378-844-15**	0.25	20.0	20	20.3	1.1	4.4	2.4	0.48×0.64	310
M Plan UV 20X	**378-837-8**	0.37	15.0	10	10.4	0.7	2.0	1.2	0.24×0.32	370
M Plan UV 50X	**378-838-8**	0.41	12.0	4	4.2	0.7	1.6	0.48	0.10×0.13	400
M Plan UV 80X	**378-839-5**	0.55	10.0	2.5	2.9	0.5	0.9	0.3	0.06×0.08	380

- When projecting a mask image on a specimen by using a YAG laser system mounted on a Mitutoyo microscope unit, the mask image will be scaled by the factor f/200 times (f=200 mm, Mitutoyo tube lens). Since the focal length (f) in ultraviolet radiation (λ=266 nm) is slightly smaller than that in visible radiation (λ=550 nm) as above, the working area in ultraviolet radiation also becomes slightly smaller than the mask image in visible radiation.
- Every resolution and single objective's depth of focus in the above table is a value determined on the basis of a reference wavelength (λ=550 nm).

Ultraviolet radiation range objectives for Bright-field observation (with cover-glass thickness compensation)

LCD Plan UV

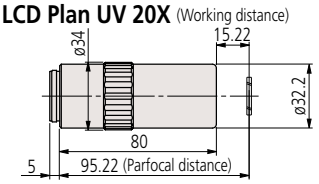
VMU FS70

Features

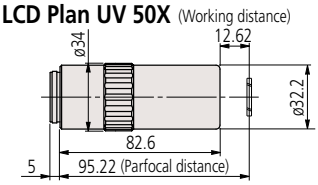
> Infinity corrected
> Suitable for bright-field observation and laser-repair based applications through LCD glass
> Long working distance
> Plan
> Designed to observe a specimen through glass 0.7 mm thick.
> This makes these lenses suitable for high-power observation through a sheet of glass.
Note: Mitutoyo is ready to design and manufacture a specific sheet of glass according to a specified glass thickness and material (or refractive index).

Dimensions

LCD Plan UV 20X (Working distance)



LCD Plan UV 50X (Working distance)



Specifications

Model	Order No.	N.A.	W.D. (mm)	f (mm)		R (μm) (λ=550 nm)	±DOF (μm)	Real FOV (mm)		Mass (g)
				f_{266}	f_{550}			ø24 eyepiece	1/2 inch camera	
LCD Plan UV										
LCD Plan UV 20X (t0.7)	**378-892-8**	0.37	14.98 *	10	10.4	0.7	2.0	1.2	0.24×0.32	370
LCD Plan UV 50X (t0.7)	**378-893-8**	0.41	12.38 *	4	4.2	0.7	1.6	0.48	0.10×0.13	400

• When projecting a mask image on a specimen by using a YAG laser system mounted on a Mitutoyo microscope unit, the mask image will be scaled by the factor f/200 times (f=200 mm, Mitutoyo tube lens). Since the focal length (f) in ultraviolet radiation (λ=266 nm) is slightly smaller than that in visible radiation (λ=550 nm) as above, the working area in ultraviolet radiation also becomes slightly smaller than the mask image in visible radiation.
• Every resolution and single objective's depth of focus in the above table is a value determined on the basis of a reference wavelength (λ=550 nm).
* In air

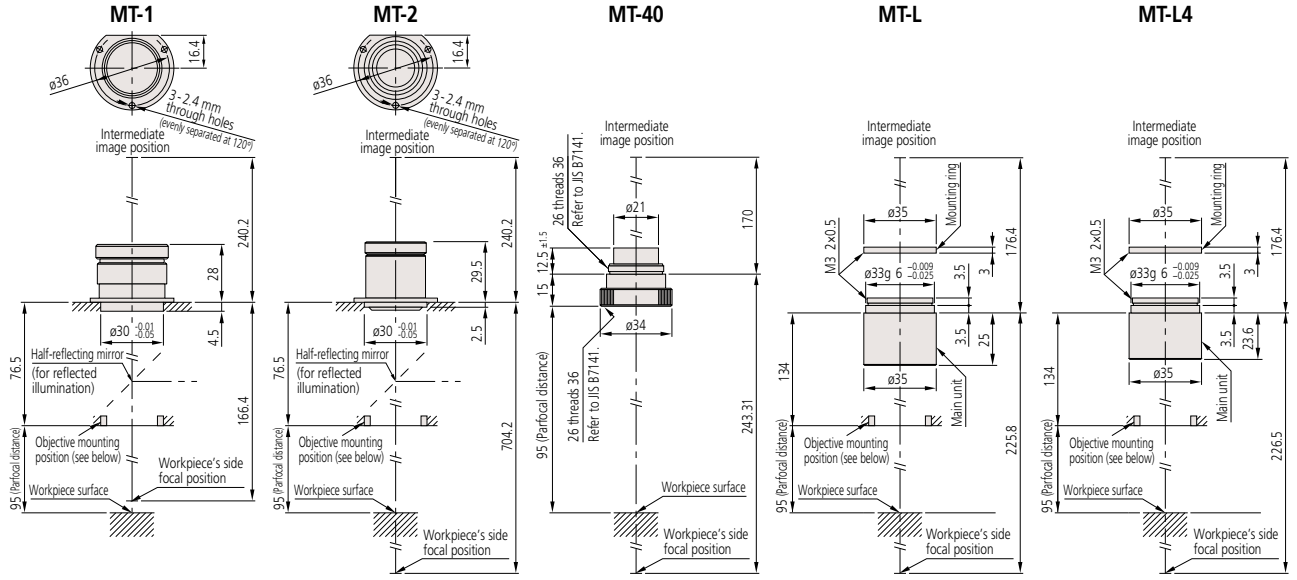
Mitutoyo

Tube Lens
MT

Aberration correction range

MT-1, **2**, **40**: Visible wavelength range (435.8 – 656.3 nm).
MT-L: Near-ultraviolet (355 nm) to near-infrared (1800 nm).
MT-L4: Ultraviolet (266 nm) to visible (620 nm).

Dimensions



Specifications

Model	Order No.	Focal length (mm)	Magnification (tube lens)	Image field (mm)	Effective lens dia. (mm)	Dimensions (mm)	Mass (g)
MT-1	**970208**	200	1X	ø30	ø24.0	ø40×32.5	43
MT-2	**970209**	400	2X	ø30	ø18.0	ø40×32.0	42
MT-40	**378-010**	200	1X	ø24	ø11.2	ø34×27.5	45
MT-L	**378-008**	200	1X	ø24	ø22.0	ø35×32.0	30
MT-L4	**378-009**	200	1X	ø24	ø23.0	ø35×30.6	30

Note: A distance of 76.5 mm in 970208 and 970209 drawings is for an image field of ø30 mm (without vignetting). For an image field of ø24 mm or ø11 mm (the latter is the image field of a 2/3-inch camera), use the formula (1) and (2) below to calculate the distance.

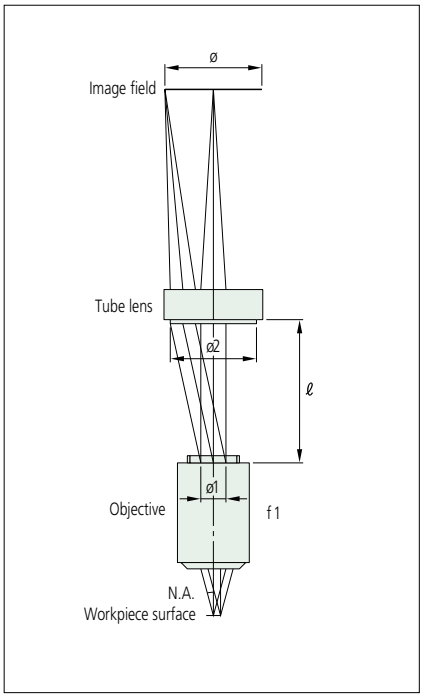
Reference: Placement of Objective and Tube Lens

Mitutoyo's long working-distance objective lenses are designed to cover a field of view of up to ø30 mm (ø24 mm), when the tube lens **970208** or **970209** (**378-008**, **378-009** or **378-010**) 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:

$\ell = (ø_2 - ø_1) \cdot f_2 / ø$ [mm] ·····(1)

$ø_1 = 2 \cdot f \cdot N.A.$ [mm] ·····(2)

$ø_1$: Objective exit pupil diameter (mm)
$ø_2$: Effective diameter of tube lens (mm)
f_2 : Focal length of tube lens (mm)
ø : Image field diameter (mm)



Example: What is the distance (ℓ), when using **M Plan Apo 10X*** and tube lens** (**970208**) to cover an image field of ø24?

*f=20 mm, N.A.=0.28 (Refer to page 19) **$ø_2$=24 mm, f_2=200 mm (Refer to the above chart)

From formula (2): $ø_1 = 2 \times 20 \times 0.28$
$= 11.2$ (mm)

From formula (1): $\ell = (24 - 11.2) \times 200/24$
$= 106.7$ (mm)

Therefore a distance (ℓ) up to 106 mm can cover an image field of ø24 mm without shading.

In other words a distance (ℓ) smaller than the specification does not affect optical performance.
Contact Mitutoyo for detailed information.

Mitutoyo

Objectives for Measuring Microscopes

ML

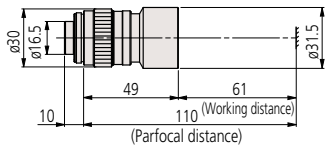
MF Hyper MF

Features

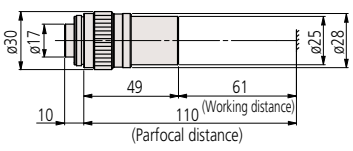
> Finite-correction
(image-object distance: 280 mm, parfocal length: 110 mm)
> Bright-field observation
> Long working distance
> Telecentric for up to 10X magnification

Dimensions

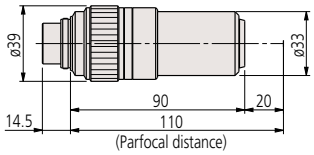
ML 1X



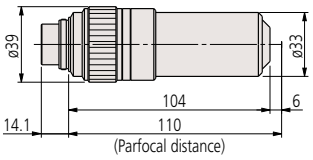
ML 5X



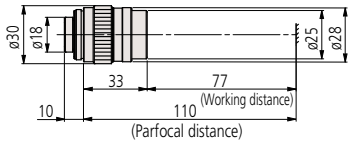
ML 20X



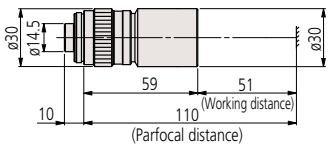
ML 100X



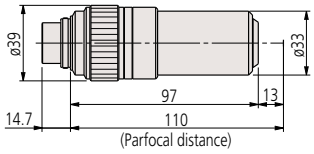
ML 3X



ML 10X



ML 50X



Note: The parfocal distance is a nominal value.

Specifications

Model	Order No.	N.A.	W.D. (mm)	R (μm) (λ = 550 nm)	±DOF (μm)	Real FOV (mm)		Mass (g)
						ø24 eyepiece	1/2 inch camera	
ML 1X	**375-036-2**	0.03	61.0	9.2	306	24	4.8×6.4	80
ML 3X	**375-037-1**	0.09	77.0	3.06	34	8	1.6×2.1	55
ML 5X	**375-034-1**	0.13	61.0	2.12	16.3	4.8	0.96×1.28	60
ML 10X	**375-039**	0.21	51.0	1.31	6.2	2.4	0.48×0.64	95
ML 20X	**375-051**	0.42	20.0	0.65	1.6	1.2	0.24×0.32	310
ML 50X	**375-052**	0.55	13.0	0.5	0.9	0.48	0.10×0.13	350
ML 100X	**375-053**	0.70	6.0	0.4	0.6	0.24	0.05×0.06	380

• Every resolution and single objective's depth of focus in the above table is a value determined on the basis of a reference wavelength (λ = 550 mm).

Objectives for Centering Microscopes

CF

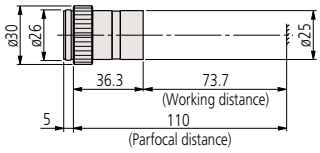
CF

Features

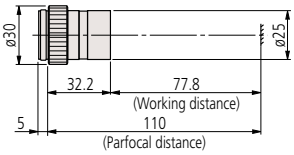
> Finite-correction
(image-object distance: 280 mm, parfocal length: 110 mm)
> Bright-field observation
> Long working distance

Dimensions

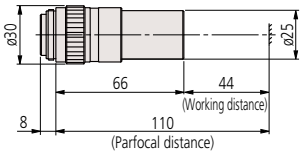
CF 1X



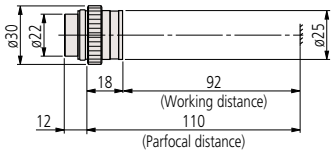
CF 3X



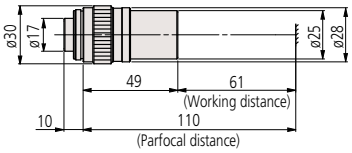
CF 10X



CF 2X



CF 5X



Note: The parfocal distance is a nominal value.

Specifications

Model	Order No.	N.A.	W.D. (mm)	R (μm) (λ = 550 nm)	±DOF (μm)	Real FOV (mm)		Mass (g)
						ø24 eyepiece	1/2 inch camera	
CF 1X	**375-031**	0.03	73.7	9.2	306	24	4.8×6.4	45
CF 2X	**375-032**	0.06	92.0	4.6	76	12	2.4×3.2	35
CF 3X	**375-033**	0.07	77.8	3.9	56	8	1.6×2.1	35
CF 5X	**375-034-1**	0.13	61.0	2.12	16.3	4.8	0.96×1.28	60
CF 10X	**375-035**	0.18	44.0	1.5	8	2.4	0.48×0.64	100

• Every resolution and single objective's depth of focus in the above table is a value determined on the basis of a reference wavelength (λ = 550 mm).

Wide Field of View Eyepieces and Reticles

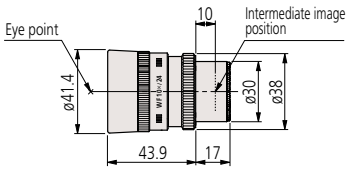
WF

MF | MF-U | Hyper MF | Hyper MF-U | FS70

Features > Eyepiece for wide field of view
> Adopt an outside focus type of optical system

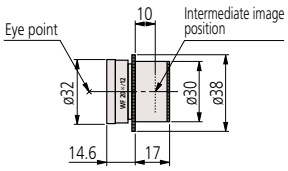
Dimensions

WF 10X/24



10X eyepiece

WF 20X/12



20X eyepiece

Specifications

Order No. (2pcs.)	Model	Magnification	Field number	Visibility adjustment	Eye point	Reticle	Mass (g)
378-866	**Wide field of view eyepiece WF10X/24**	10X	24	-10 D to +5 D	High eye point	Available	150
378-858	**Wide field of view eyepiece WF20X/12**	20X	12	-8 D to +5 D	Normal	Available	55

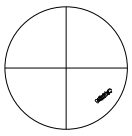
Note: The above lenses are provided as a set of 2.

Reticles

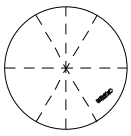
Features > Various reticles can be attached according to usage purposes.

Dimensions

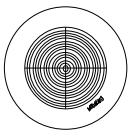
No.516848



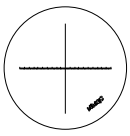
No.516576



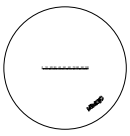
No.516578



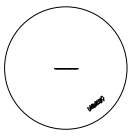
No.516577



No.516849



No.516850



Specifications

Order No.	516848	516576	516578	516577	516849	516850
Remarks	Solid crosshairs	90° and 60° broken crosshairs	Concentric circles (ø1.2 -18 mm) with solid crosshairs	Solid crosshairs with scale graduated 0.1 mm/20 mm	10 mm scale with 0.1 mm graduations	5 mm scale with 0.05 mm graduations

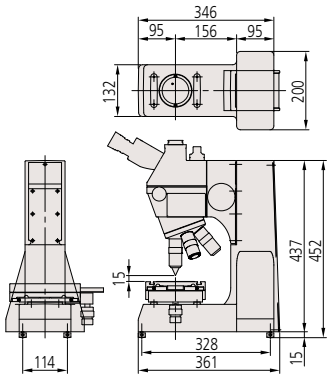
Optional Accessories for VMU, WIDE VMU, and FS70

Stand

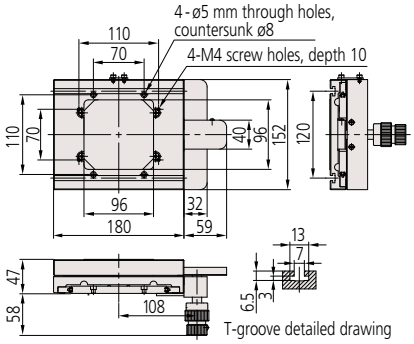
For mounting the VMU, WIDE VMU, or FS70 microscope unit. Can be combined with an XY stage, stage illumination unit and fiber-optic illuminator to work as a compact microscope for surface observation.

Order No.	**378-730**
Mass	6.7 kg

Stand with XY stage and stage illumination unit mounted on FS70Z with optional objectives and eyepieces



XY stage

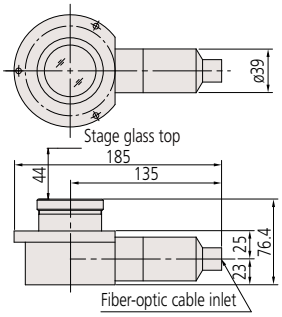


Order No.	**378-020**
Travel range	50x50 mm
Handle feed	34 mm/rev.
Mass	3.3 kg

Note: Each wheel functions as a single-axis drive.

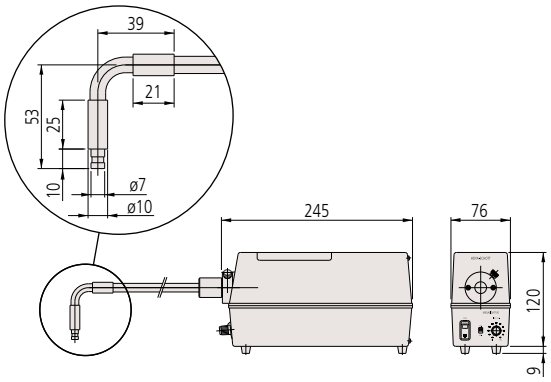
Stage illumination unit

Attaches to the stand to provide contour illumination in conjunction with a fiber-optic illuminator (100 W or 150 W).



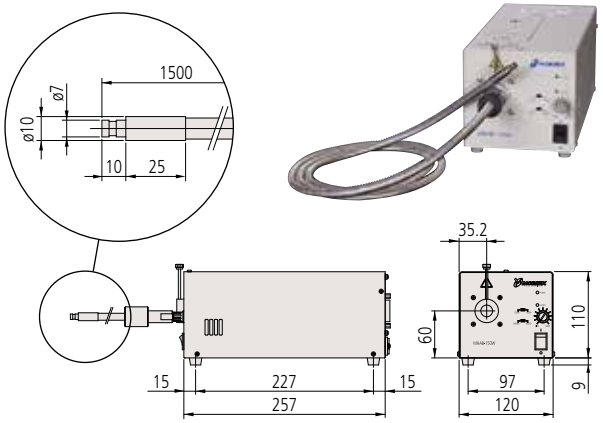
Order No.	**378-736**
Mass	0.8 kg

Fiber-optic illuminator (100 W)



Order No.		**378-700**
Light source		12 V/100 W parabolic-type halogen bulb (**517181**), 100 h service life
Light guide		Fiber-optic cable (1.5 m length, 5 mm dia.)
Brightness		Manually adjustable
Filter (optional)	**ND2**	For 1/2 light intensity (**12AAB251**)
	ND8	For 1/8 light intensity (**12AAB252**)
	GIF	Green filter (**12AAG806**)
	LB80	Color temperature conversion filter (**12AAG807**)

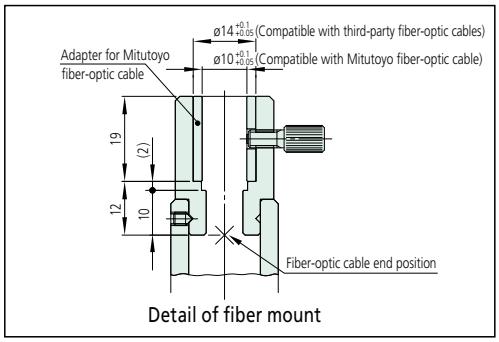
Fiber-optic illuminator (150 W)



Order No.		**176-316**
Light source	Long-life type	15 V/150 W parabolic-type halogen bulb (**12BAJ076**), 500 h service life
	High-brightness type	15 V/150 W parabolic-type halogen bulb (**12BAJ075**), 50 h service life
Light guide		Fiber-optic cable (1.5 m length, 5 mm dia.)
Brightness		Manually adjustable

Bulb replacement	Standard: Halogen bulb (12 V, 100 W) (**517181**)
	For the fiber-optic cable illumination unit (12 V, 100 W) (**378-700**)

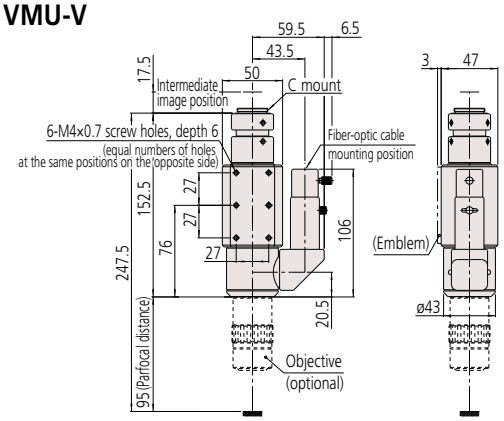
Dimensions



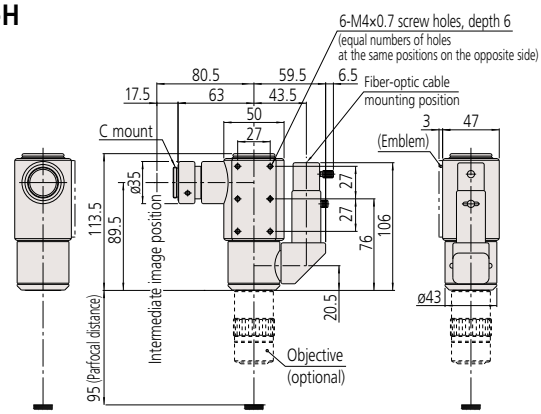
Detail of fiber mount

VMU series

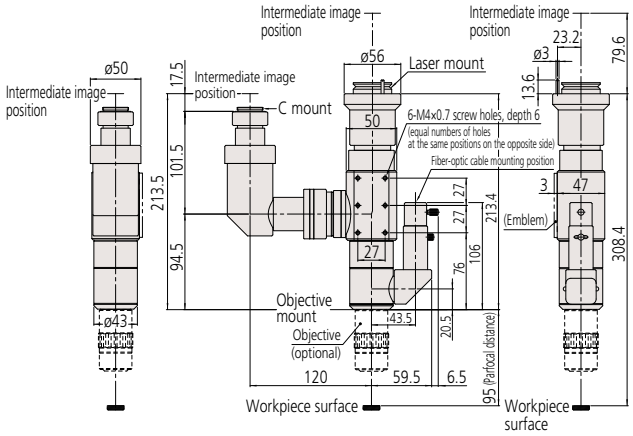
VMU-V



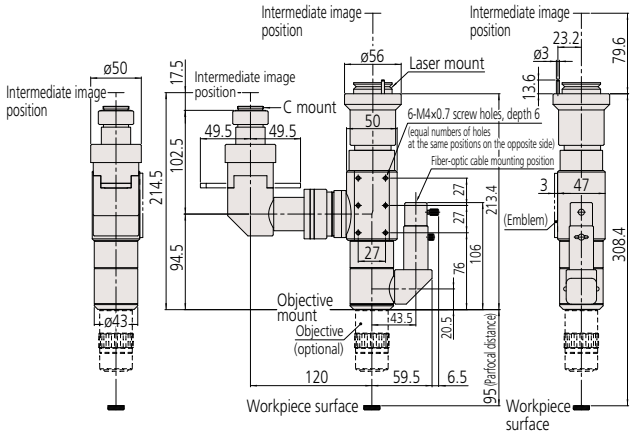
VMU-H



VMU-LB

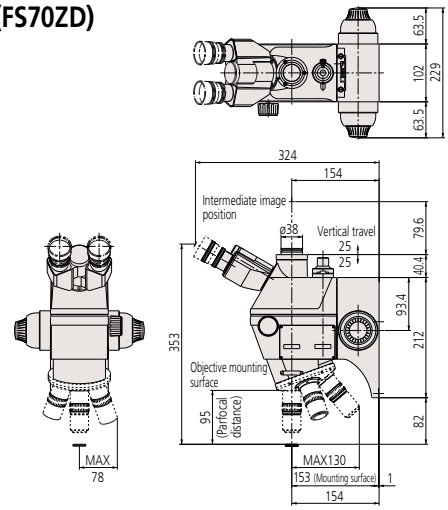


VMU-L4B

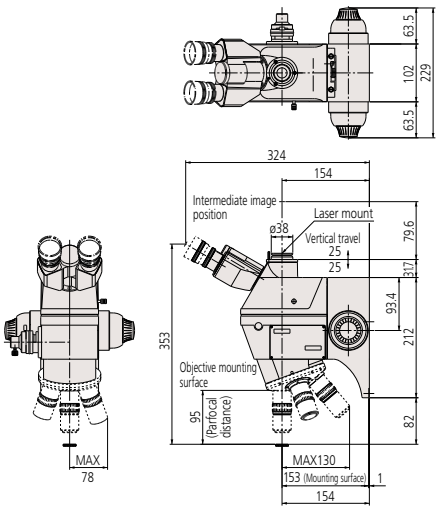


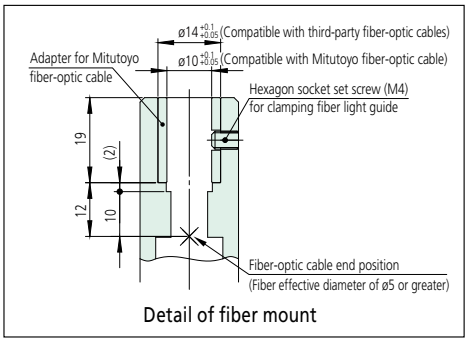
FS70 series

FS70Z (FS70ZD)



FS70L

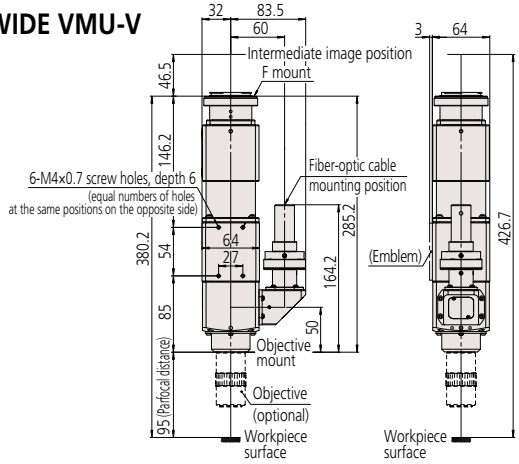




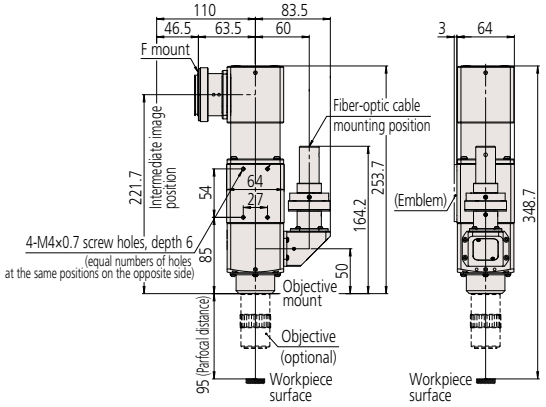
Detail of fiber mount

WIDE VMU series

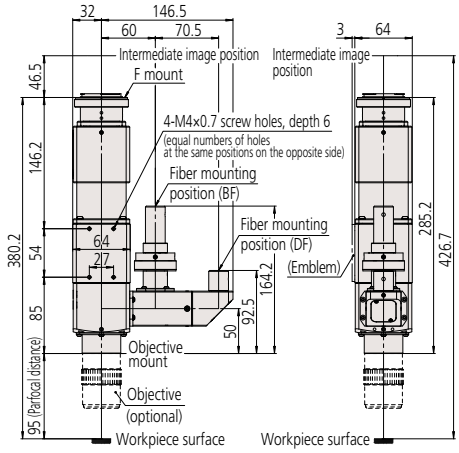
WIDE VMU-V



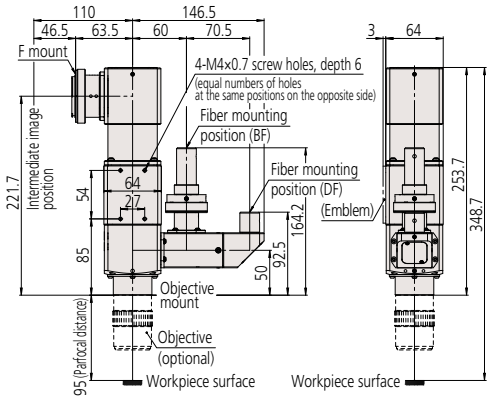
WIDE VMU-H



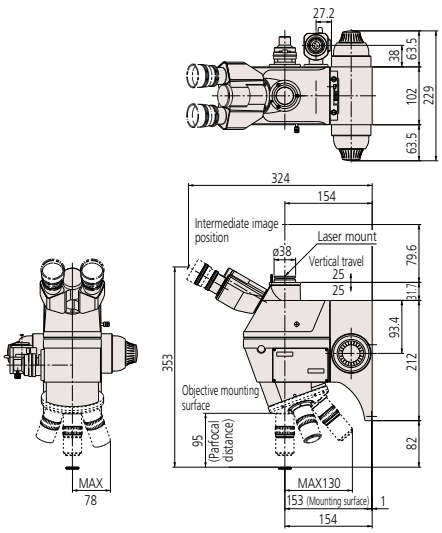
WIDE VMU-BDV

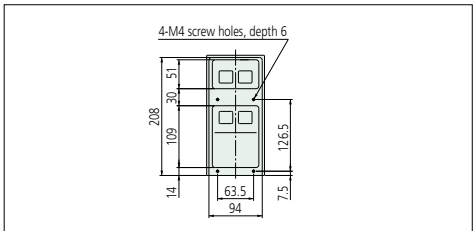


WIDE VMU-BDH

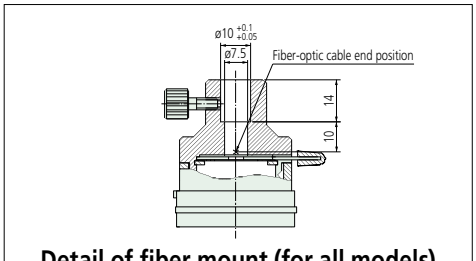


FS70L4





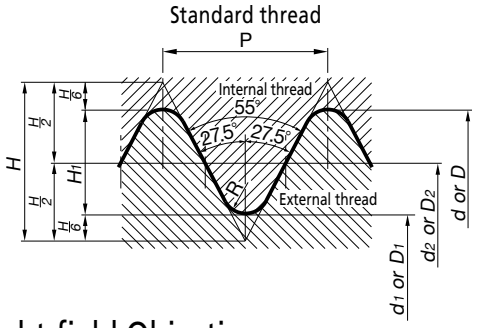
Back of standard focus unit (for all models)

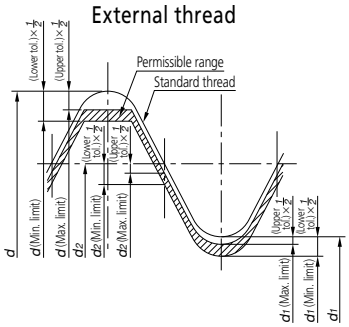


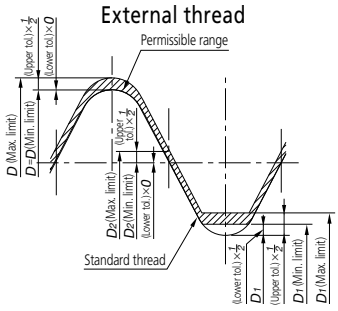
Detail of fiber mount (for all models)

Reference: Specifications of Objective Threads

1. Scope: These specifications are applied to the threads of Mitutoyo microscope objectives.
2. The thread forms and dimensions are specified as follows conforming to JIS B-7141-1994.







Bright-field Objectives
Measuring Microscope/Centering Microscope Objectives

Nominal Dimensions

Unit: mm

Nominal thread diameter	Number of threads (per 25.4 mm) n	Pitch P	Thread peak & valley curvature radius R	External thread		
				OD (d)	Pitch diameter (d_2)	Root diameter (d_1)
				Internal thread		
				Root diameter (D)	Pitch diameter (D_2)	ID (D_1)
26	36	0.706	0.097	26.000	25.548	25.096

Permissible Limits of Size and Dimensional Tolerance

Unit: mm

Applicable dimensions		External thread			Internal thread		
		OD (d)	Pitch diameter (d_2)	Root diameter (d_1)	Root diameter (D)	Pitch diameter (D_2)	ID (D_1)
Permissible limits	Max. limit	25.896	25.502	25.050	26.076	25.624	25.230
	Min. limit	25.820	25.426	24.974	26.000	25.548	25.154
Dimensional tolerance	Upper tolerance	–0.104	–0.046	–0.046	+0.076	+0.076	+0.134
	Lower tolerance	–0.180	–0.122	–0.122	0	0	+0.058

Bright/Dark-field Objectives

Nominal Dimensions

Unit: mm

Nominal thread diameter	Number of threads (per 25.4 mm) n	Pitch P	Thread peak & valley curvature radius R	External thread		
				OD (d)	Pitch diameter (d_2)	Root diameter (d_1)
				Internal thread		
				Root diameter (D)	Pitch diameter (D_2)	ID (D_1)
40	36	0.706	0.097	40.000	39.548	39.096

Permissible Limits of Size and Dimensional Tolerance

Unit: mm

Applicable dimensions		External thread			Internal thread		
		OD (d)	Pitch diameter (d_2)	Root diameter (d_1)	Root diameter (D)	Pitch diameter (D_2)	ID (D_1)
Permissible limits	Max. limit	39.896	39.502	39.050	40.076	39.624	39.230
	Min. limit	39.820	39.426	38.974	40.000	39.548	39.154
Dimensional tolerance	Upper tolerance	–0.104	–0.046	–0.046	+0.076	+0.076	+0.134
	Lower tolerance	–0.180	–0.122	–0.122	0	0	+0.058

Reference: Transmission of Mitutoyo Objectives

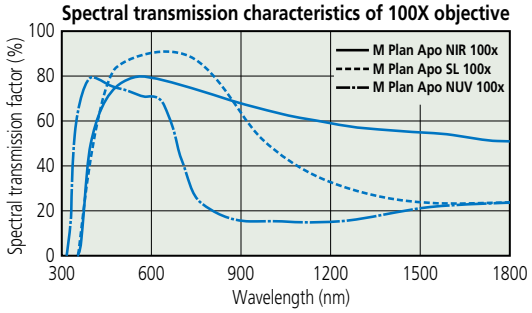
Mitutoyo's long working-distance objectives are grouped by working wavelength range: ultraviolet, near-ultraviolet, visible, and near-infrared. The M Plan UV series (for ultraviolet), M Plan Apo NUV series (for near-ultraviolet), and M Plan Apo NIR series (for near-infrared) are designed especially for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

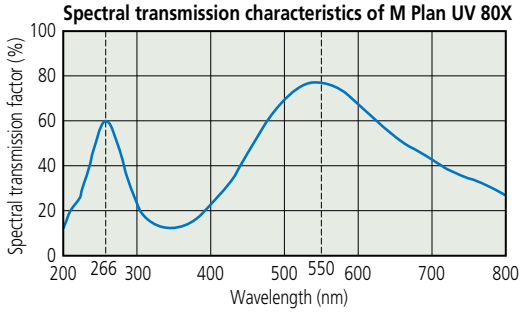
M (BD) Plan Apo series: Wavelength range 436 nm to 656 nm

M Plan Apo NIR series: Wavelength range 480 nm to 1800 nm

M Plan Apo NUV series: Wavelength range 355 nm to 620 nm

M Plan UV series: Optimized for wavelengths of 266 nm and 550 nm





N.A.: Numerical aperture W.D.: Working distance f: Focal length R: Resolving power DOF: Depth of field FOV: Real field of view

Commentary: Laser Operating Method and Precautions

Each VMU and FS70 series of Mitutoyo microscope units can be used with a laser [mainly, Nd-YAG laser fundamental wavelength (1064 nm), second harmonic (532 nm), third harmonic (355 nm) and fourth harmonic (266 nm)] to allow laser machining. In laser machining with a laser-equipped microscope unit and a microscope objective, high-power laser irradiation is not allowed for the purpose of microfabrication.
IMPORTANT: Review laser safety precautions prior to use.

Laser Input Conditions of Laser-equipped Microscope Unit

Determine the upper limit value of laser input under the following conditions. Laser radiation incident on the optical system shall be axial and non-polarized.

VMU Series

Applicable model	VMU-LB			VMU-L4B			
Wavelength used (nm)	1064	532	355	1064	532	355	266
Pulsed laser Upper input limit (J/cm^2) Pulse width (10 ns)	0.099	0.075	0.025	0.11	0.080	0.035	0.015
Upper limit to CW laser input (kW/cm^2)	0.22	0.18	0.07	0.2	0.19	0.05	0.05

FS70 Series

Applicable model	FS70L			FS70L4	
Wavelength used (nm)	1064	532	355	532	266
Pulsed laser Upper input limit (J/cm^2) Pulse width (10 ns)	0.090	0.075	0.018	0.075	0.015
Upper limit to CW laser input (kW/cm^2)	0.23	0.18	0.06	0.2	0.05

Upper Limit to Objective Laser Input

Determine the upper limit value of laser input under the following conditions if the laser radiation directly enters the objective.
Laser radiation incident on the optical system shall be axial.

Objectives

Applicable objective	NIR series	NIR series NUV series UV series	NUV series	UV series
Wavelength used (nm)	1064	532	355	266
Pulsed laser Upper input limit (J/cm^2) Pulse width (10 ns)	0.2	0.1	0.05	0.04
Upper limit to CW laser input (kW/cm^2)	0.5	0.25	0.16	0.12

Note: If the pulse width of the laser is shortened, reduce the irradiation energy density by the square root of the ratio of the new pulse width to the initial pulse width.

Example: If the pulse width decreases to 1/4 of the initial width, reduce the energy density to approximately 1/2.
Therefore when using a laser with a wavelength of 1064 nm and a pulse width of 2.5 ns, the upper limiting value of input will be 0.1 J/cm^2.

Mitutoyo

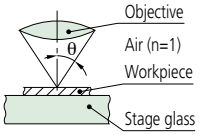
Glossary

1. N.A. (Numerical Aperture)

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

$$N.A. = n \cdot \sin\theta$$

n is the index of refraction of the medium in which the lens is working. n = 1.0 for air.
θ is the half-angle of the maximum cone of light that can enter or exit the lens.



2. R (Resolving Power)

Minimum distance between points or lines that are just distinguishable as separate entities.
Resolving power is determined by N.A. and wavelength λ.

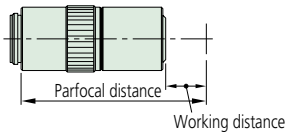
$$R\ (\mu m) = \frac{\lambda}{2 \cdot N.A.}$$

3. W.D. (Working distance)

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

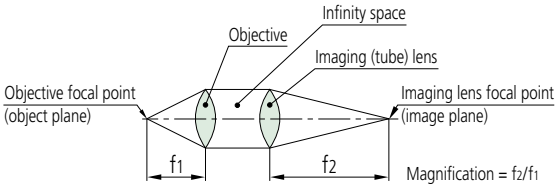
4. Parfocal Length

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



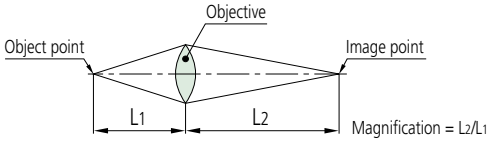
5. Infinity-corrected system

An optical system in which the image is formed by an objective and a tube lens with an 'Infinity Space' between them, into which optical accessories can be inserted.



6. Finite-corrected optical system

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



7. F (Focal Length)

Distance between a principal point and a focal point. f^1 is the focal length of an objective, f^2 is the focal length of a tube lens. Magnification is determined by the ratio of the focal length of the tube lens to that of the objective. (For an infinity-corrected optical system.)

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

$$\text{(E.g.) } 1X = \frac{200\ (mm)}{200\ (mm)} \qquad \text{(E.g.) } 10X = \frac{200\ (mm)}{20\ (mm)}$$

8. Field number and FOV (Real Field of View)

The field number of an eyepiece is determined by the field stop diameter of the eyepiece and it is expressed in mm.

FOV is the area of specimen observable and is determined by the field number of the eyepiece and magnification of the objective.

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

(E.g. Using an eyepiece of field number 24)

$$\text{FOV for 1X objective} = \frac{24}{1} = \text{ø}24\ (mm)$$

$$\text{FOV for 10X objective} = \frac{24}{10} = \text{ø}2.4\ (mm)$$

Area of specimen observable on TV monitor

$$\text{Area of specimen observable on TV monitor} = \frac{\text{Area of camera image element (VxH)}}{\text{Magnification of objective}}$$

Indication magnification on TV monitor

$$\text{Indication magnification on TV monitor} = \text{Magnification of objective} \times \frac{\text{Diagonal line length of monitor indication}}{\text{Diagonal line length of camera image element}}$$

Note: Size of camera image element (V x H x Diagonal)
1/3 inch image element: 3.6x4.8x6.0 mm 1/2 inch image element: 4.8x6.4x8.0 mm
2/3 inch image element: 6.6x8.8x11.0 mm

9. DOF (Depth of Field)

Vertical distance in the specimen, measured from above and below the exact plane of focus, which still yields an acceptable image.
The larger the N.A., the smaller the depth of field.

Eyepiece observation (Formula due to Berek)

$$\pm DOF\ (\mu m) = \frac{\omega \times 250.000}{N.A. \times M} + \frac{\lambda}{2 \times (N.A.)^2}$$

λ = Standard wavelength (550 nm)

ω: Resolution of human eye (Visual angle: 5 minutes)
M: Total magnification (Objective mag. x Eyepiece mag.)

TV monitor observation

$$\pm DOF\ (\mu m) = \frac{\lambda}{2 \times (N.A.)^2}$$

λ = Standard wavelength (550 nm)

10. Bright-field illumination and dark-field illumination

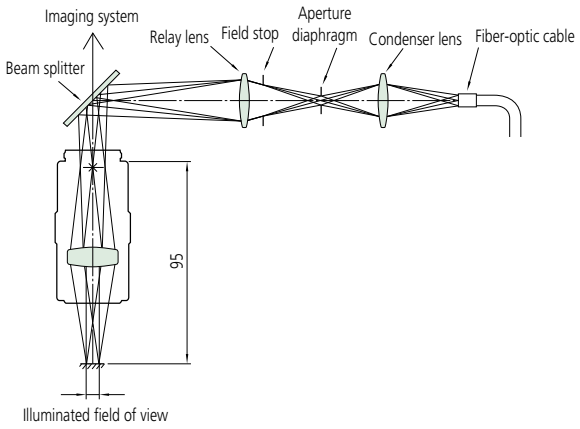
Bright-field illumination directly lights the specimen with a solid cone of rays and is the simplest method available. Dark-field illumination uses a hollow cone of rays formed by an opaque stop at the center of the condenser large enough to prevent direct light from entering the objective. The specimen is placed at the concentration of the light cone, and is seen with light scattered or diffracted by it, therefore scratches and dents on the specimen surface are illuminated while the rest remains dark.

11. Apochromatic objective and achromatic objective

An apochromatic objective is corrected for chromatic aberration at the red, blue, and yellow wavelengths. An achromatic objective is corrected for chromatic aberration at the red and yellow wavelengths only.

12. Koehler illumination

Köhler illumination overcomes the disadvantages of other schemes by causing parallel rays to light the specimen so that, because they will not be in focus, the image of the specimen will not include an image of the light source.



13. Telecentric illumination

This illuminating optical system is designed so that principal light passes through the focal point. This system has the advantage of retaining the size of the image center even if it is out of focus (although the circumference of the image is defocused). This illumination system provides an even illumination intensity over the entire field of view.

14. Aperture diaphragm

This diaphragm adjusts the amount of light passing through and is related to the brightness and resolving power of an optical system. This diaphragm is especially useful in width dimension measurement of cylindrical objects with contour illumination, and provides the highest degree of correct measurement/observation by suppressing diffraction in an optimal aperture.

15. Field stop

This diaphragm is used for blocking out unwanted light and thereby preventing it from degrading the image.

16. Plan

Denotes an objective lens that produces a flat (planar) image by correcting the spherical aberration/curvature of the field of an achromatic lens or an apochromatic lens. All Mitutoyo FS series objectives are plan apochromat.

17. Vignetting

This unwanted effect is the reduction of an image's brightness or saturation at the periphery compared to the image center. May be caused by external (lens hood) or internal features (dimensions of a multi-element lens).

18. Flare

Lens flare is typically seen as several starbursts, rings, or circles in a row across the image or view, caused by unwanted image formation mechanisms, such as internal reflection and scattering of light.

19. Double image

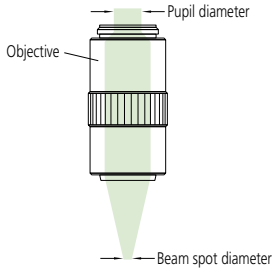
An image degrading a phenomenon in which an image appears as if it is a double image due to redundant light projection and optical interference within the optical system.

20. Pupil Diameter and Spot Diameter of an Objective

• Pupil diameter

Denotes the maximum diameter of a parallel light flux along the optical axis that can enter an objective from the rear. The pupil diameter is calculated according to the following expression.

$$\text{ø mm} = 2 \times \text{N.A.} \times f_1$$



• Spot diameter

If a beam of light with a uniformly distributed intensity enters an objective from the rear, the beam is focused to a spot of finite size. This size is known as the spot diameter. The approximate value of a spot diameter is calculated from the following expression.

$$\text{øμm} = 1.22 \times \frac{\lambda}{\text{N.A.}}$$

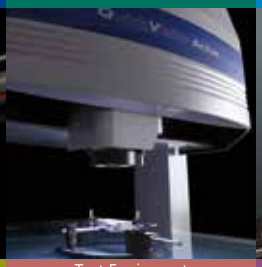
However, the above expression cannot be applied if the light source is a laser beam of which the intensity forms a Gaussian distribution on the cross section. The diameter of a laser beam is generally indicated by $1/e^2$ of the peak value, i.e. 13.5% of the peak value. The spot diameter of a laser beam is calculated from the following expression.

$$\text{øμm} = \frac{4 \times \lambda \times f}{\pi \times D}$$

(where λ is in μm; f and D are in mm)

Coordinate Measuring Machines

Vision Measuring Systems



Form Measurement

Optical Measuring

Sensor Systems

Test Equipment and Seismometers

Digital Scale and DRO Systems

Small Tool Instruments and Data Management

Whatever your challenges are, Mitutoyo supports you from start to finish.

Mitutoyo is not only a manufacturer of top quality measuring products but one that also offers qualified support for the lifetime of the equipment, backed up by comprehensive services that ensure your staff can make the very best use of the investment.

Apart from the basics of calibration and repair, Mitutoyo offers product and metrology training, as well as IT support for the sophisticated software used in modern measuring technology. We can also design, build, test and deliver bespoke measuring solutions and even, if deemed cost-effective, take your critical measurement challenges in-house on a sub-contract basis.

Find additional product literature and our product catalogue

www.mitutoyo.eu

Note: All information regarding our products, and in particular the illustrations, drawings, dimensional and performance data contained in this printed matter as well as other technical data are to be regarded as approximate average values. We therefore reserve the right to make changes to the corresponding designs, dimensions and weights. The stated standards, similar technical regulations, descriptions and illustrations of the products were valid at the time of printing. In addition, the latest applicable version of our General Trading Conditions will apply. Only quotations submitted by ourselves may be regarded as definitive.

Mitutoyo

Mitutoyo Europe GmbH

Borsigstraße 8-10
41469 Neuss

Tel. +49 (0) 2137-102-0
Fax +49 (0) 2137-102-351

info@mitutoyo.eu
www.mitutoyo.eu