

MICROSCOPE UNITS AND OBJECTIVES

(UV, NUV, VISIBLE & NIR REGION)

CATALOG No. E4191-378



Microscope viewing units and objectives for practically every application

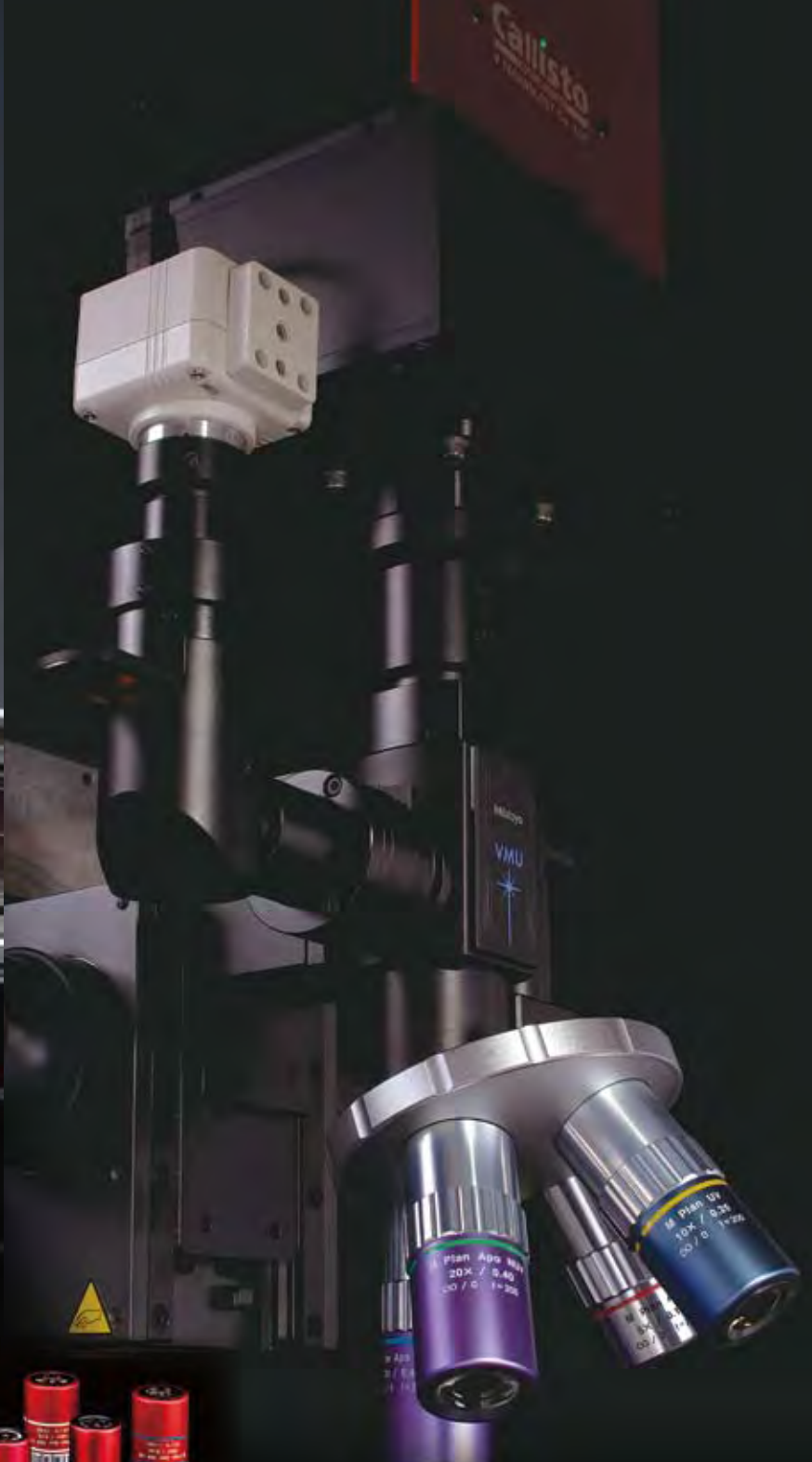
Mitutoyo



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://elife.miyakyo-u.ac.jp/opac/2008/03/cd_2.html)



A wealth of Applications

System with digital camera



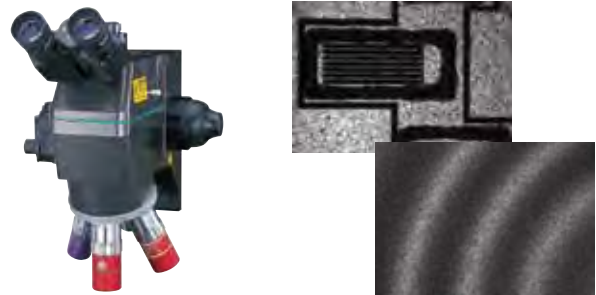
Digital microscopic system using VMU-V

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 inverted positions according to your application requirements.

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

Dual-camera systems featuring high and low magnification and differential interference observation are also available.

System for IR analysis/inspection



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

- > Micro-fluid analysis
- > 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 of wafer junctions, spectral characteristics analysis using infrared
- > Femtosecond laser applications

Systems for laser applications



UV laser application using VMU-L4B



Flaking of polyimide membrane



SEM photograph of IC surface after removing upper layer



UV laser application using FS70L4

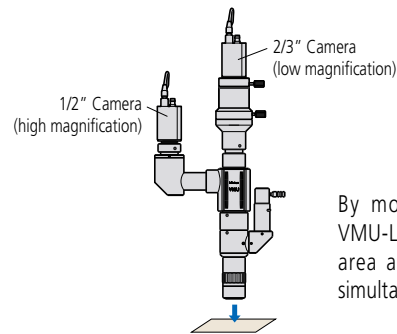


Color filter working

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

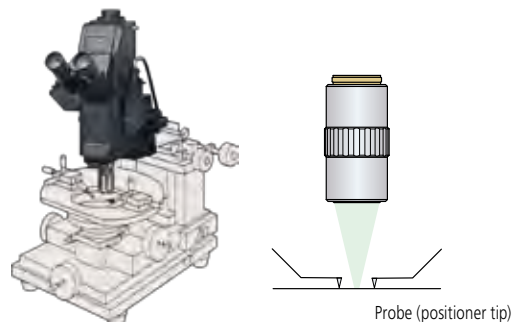
- > Peeling off protective films and organic thin-films
- > Cutting of IC wiring (Au, Al) and exposure of lower layer pattern
- > FPD defects repair
- > Photomask repair
- > Marking, trimming, patterning, spot annealing and scribing

System for dual-camera (high & low magnification) observation



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

System for analysis



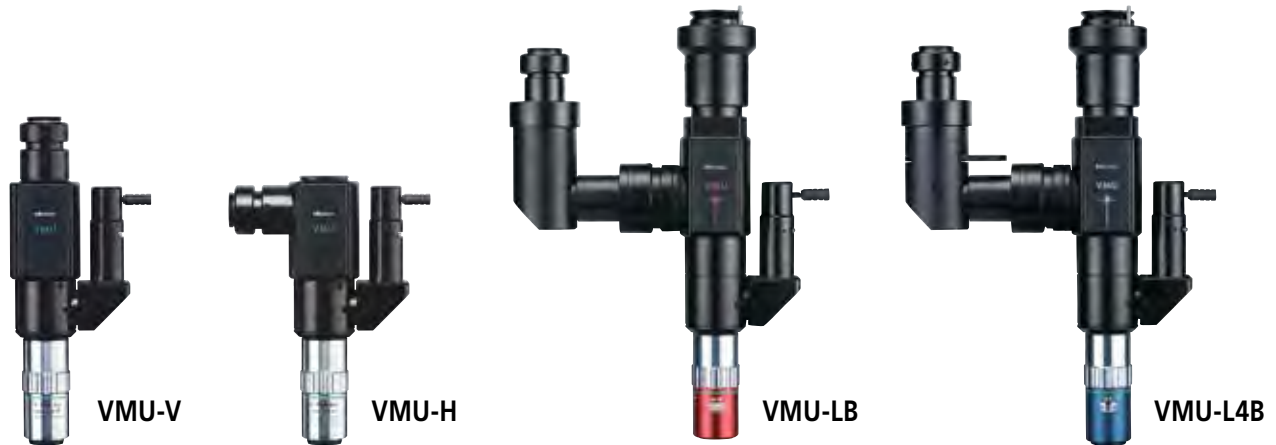
The Mitutoyo M Plan Apo objectives provide a long working distance. This allows you to design an optical system for defects evaluation of semiconductor integrated circuits and precise repair with YAG lasers. The optical system for direct observation is also available.



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Video Microscope Unit VMU



*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.
- > **Compatible with YAG lasers (1064nm, 532nm, 355nm and 266nm)**
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 system**
Available for internal observation of IC packages and spectral characteristics analysis using an infrared source and camera.
- > **Standard of telecentric reflective 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).**

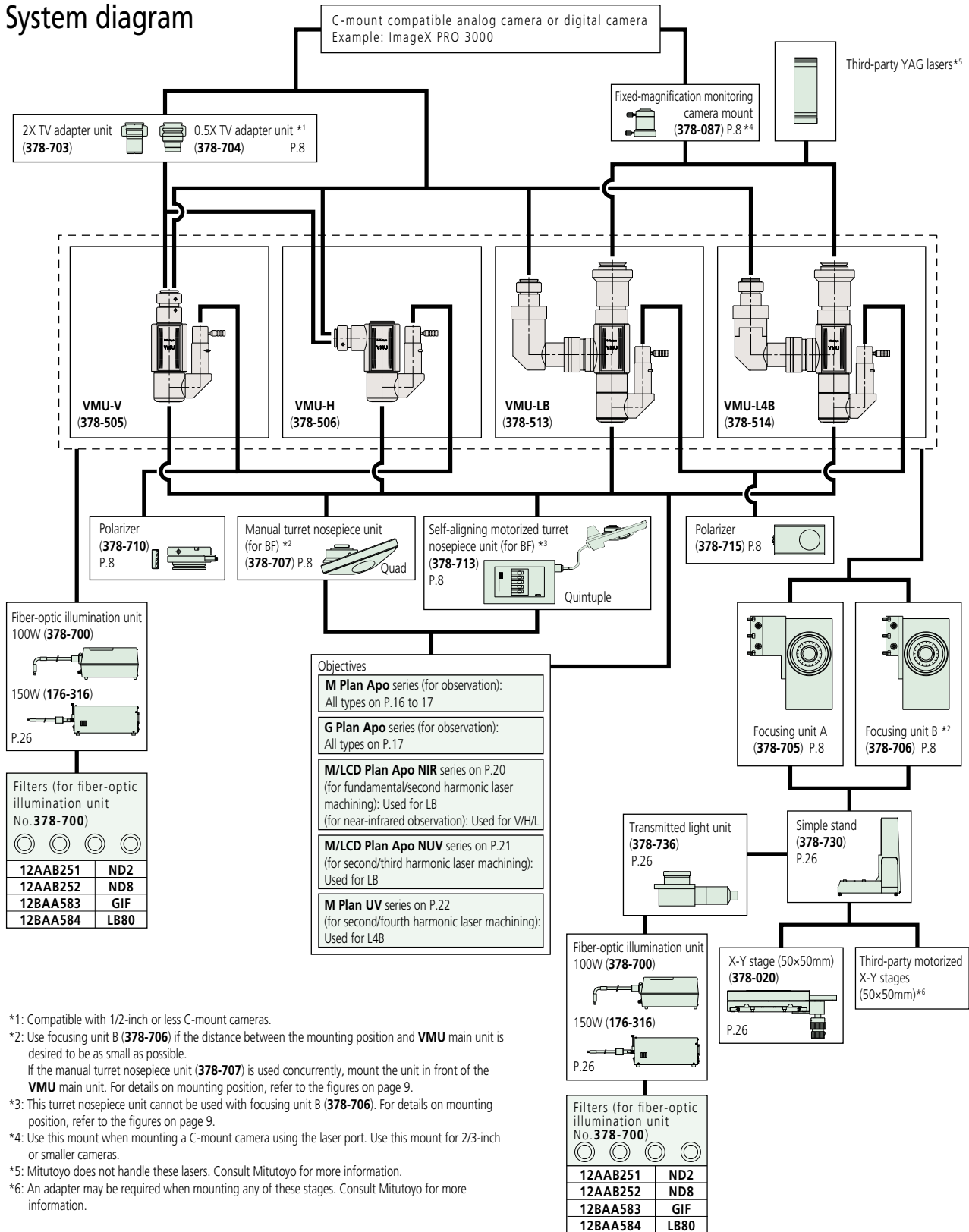
Specifications

Model No.	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)	Vertical (rotatable)
Observation	BF, erect image	BF, inverted image	BF, erect image	
Optical tube	Camera port	Magnification: 1X; Wavelength (λ): visible radiation		
	Optical features	C-mount with centering and parfocal adjustment and green filter switch		
	Mount	C-mount (centering and parfocal adjustment)		
	Tube lens (correction range)	1X (visible - NIR)		1X (UV - visible - NIR)
	Optical features	—		Magnification: 1X λ: 355/532/1064μm
Laser port	Optical features	—		
	Mount	—		
	Suitable YAG laser type*2	—		With parfocal adjustment
Polarizer*1	Available for observation		Fundamental, second and third-harmonic mode	Fundamental and second, third and fourth-harmonic mode
	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	M/LCD Plan Apo NIR, M/LCD Plan Apo NUV, M Plan UV
Suitable camera	2/3" or smaller C-mount compatible type			
Optical system illumination	Telecentric reflective with aperture diaphragm			
Fiber-optic illuminator (optional)	12V/100W (378-700D), 12V/150W (178-316D)			
Mass (Dimensions: Refer to page 27.)	650g	750g	1270g	1300g

*1: M Plan Apo 1X objective should be used together with the polarizer (378-710 or 378-715).

*2: When mounting a laser, ensure all safety precautions are observed and be aware of laser output power, beam energy density and the unit's weight. Please consult Mitutoyo if in doubt.

System diagram



*1: Compatible with 1/2-inch or less C-mount cameras.

*2: Use focusing 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 focusing 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.



Order No.	378-707
Observation method	Bright field
No. of objective mounts	4
Mass	780g

Installed on VMU-V with optional objectives

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 VMU-V with optional objectives

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. A power focus unit is also available. Refer to page 12.

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	50mm	
Coarse/fine feed	Coarse: 3.8mm/rev., Fine: 0.1mm/rev.	
Loading capacity	Approx. 17.4kg	Approx. 17.7kg
Mass	2.9kg	2.7kg

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" or smaller type	1/2" or smaller type
Mass	25g	25g

Polarizer

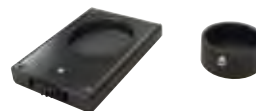
Provides simplified polarized light observation. Also enhances contrast of low-magnification objectives.

378-710: For VMU-V and VMU-H

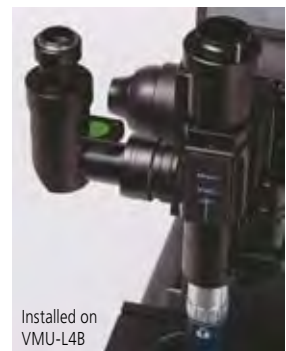
378-715: For VMU-LB and VMU-L4B



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

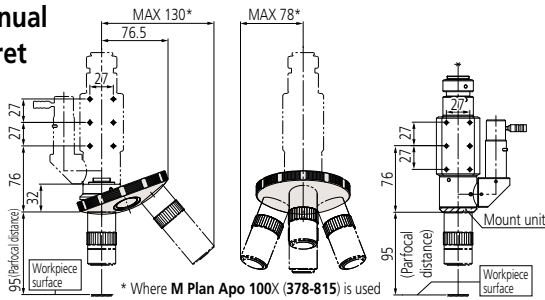


378-087 Mass: 180g

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

Dimensions of Optional Accessories for VMU Series

Manual turret



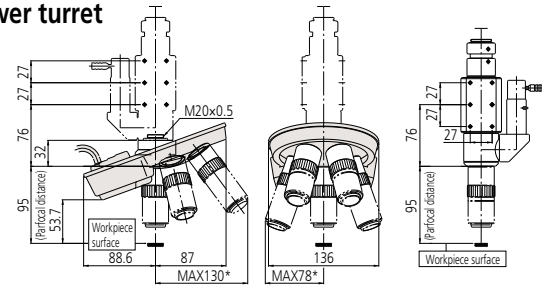
* Where M Plan Apo 100X (378-815) is used

When mounting the turret on **VMU-V** or **VMU-H**

Note 1: The lens mount must be removed from VMU.

Note 2: The turret can be fixed in the desired position relative (inward, outward, etc.) to the mounting surface. (VMU-H only)

Power turret

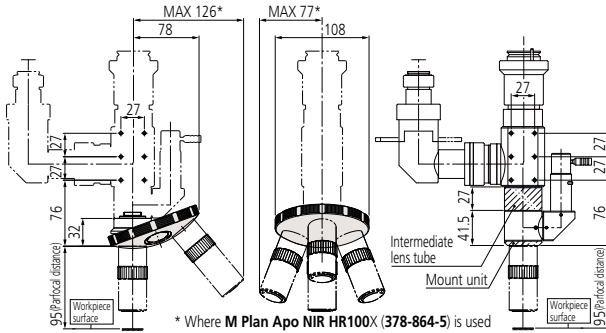


* Where M Plan Apo 100X (378-815) is used

When mounting the turret on **VMU-V** or **VMU-H**

Note 1: The lens mount must be removed from VMU.

Note 2: The turret can be fixed in the desired position relative (inward, outward, etc.) to the mounting surface. (VMU-H only)

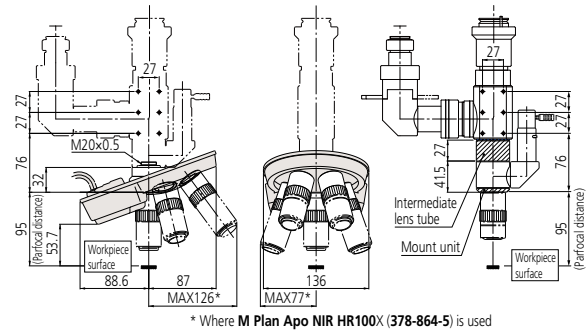


* Where M Plan Apo NIR HR100X (378-864-5) is used

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 turret can be fixed at 45° intervals around the optical axis.



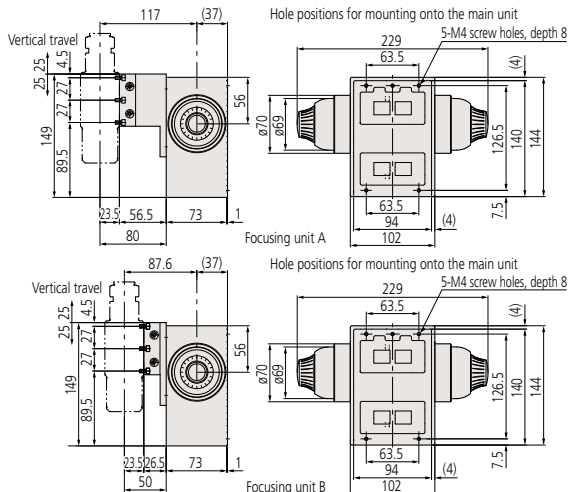
* Where M Plan Apo NIR HR100X (378-864-5) is used

When mounting the turret on **VMU-LB** or **VMU-L4B**

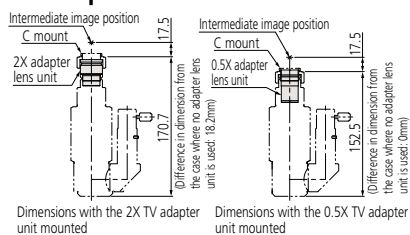
Note 1: The middle optical tube and lens mount must be removed from VMU.

Note 2: The turret can be fixed in the desired position relative to the optical axis.

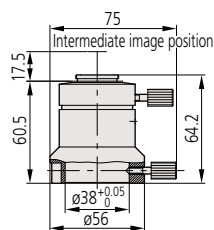
Focus unit A and B



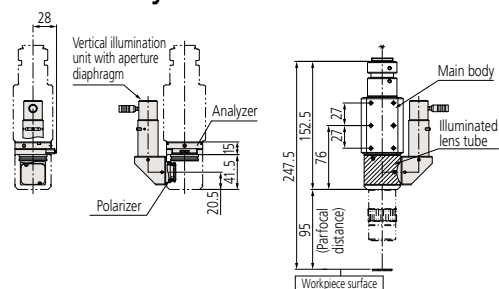
TV adapter unit



Camera mount

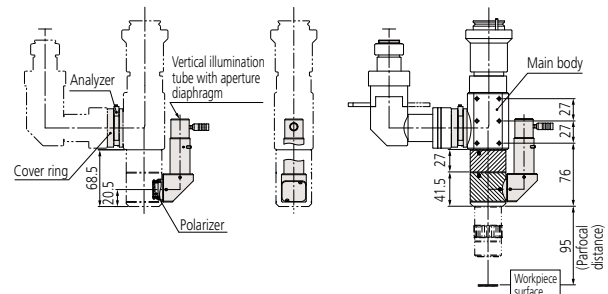


Polarizer and Analyzer



Installing the polarizer and analyzer on **VMU-V** or **VMU-H**

Note: The analyzer is installed by opening the main body mirror head. The polarizer is installed by removing the illumination tube.



When installing the polarizer on **VMU-LB** or **VMU-L4B**

Note 1: The analyzer is installed by loosening the cover ring. The polarizer is installed by removing the illumination tube.

Microscope Unit FS70 Series



FS70Z



FS70L



FS70L4

*Objectives and eyepieces shown mounted are optional.

Features

> Compact microscope unit with trinocular eyepiece tube

Suitable for observation of many different types of object: metal surfaces, semiconductors, LCDs, resins, etc.

> Compatible with YAG lasers (1064nm, 532nm, 355nm and 266nm)

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

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.

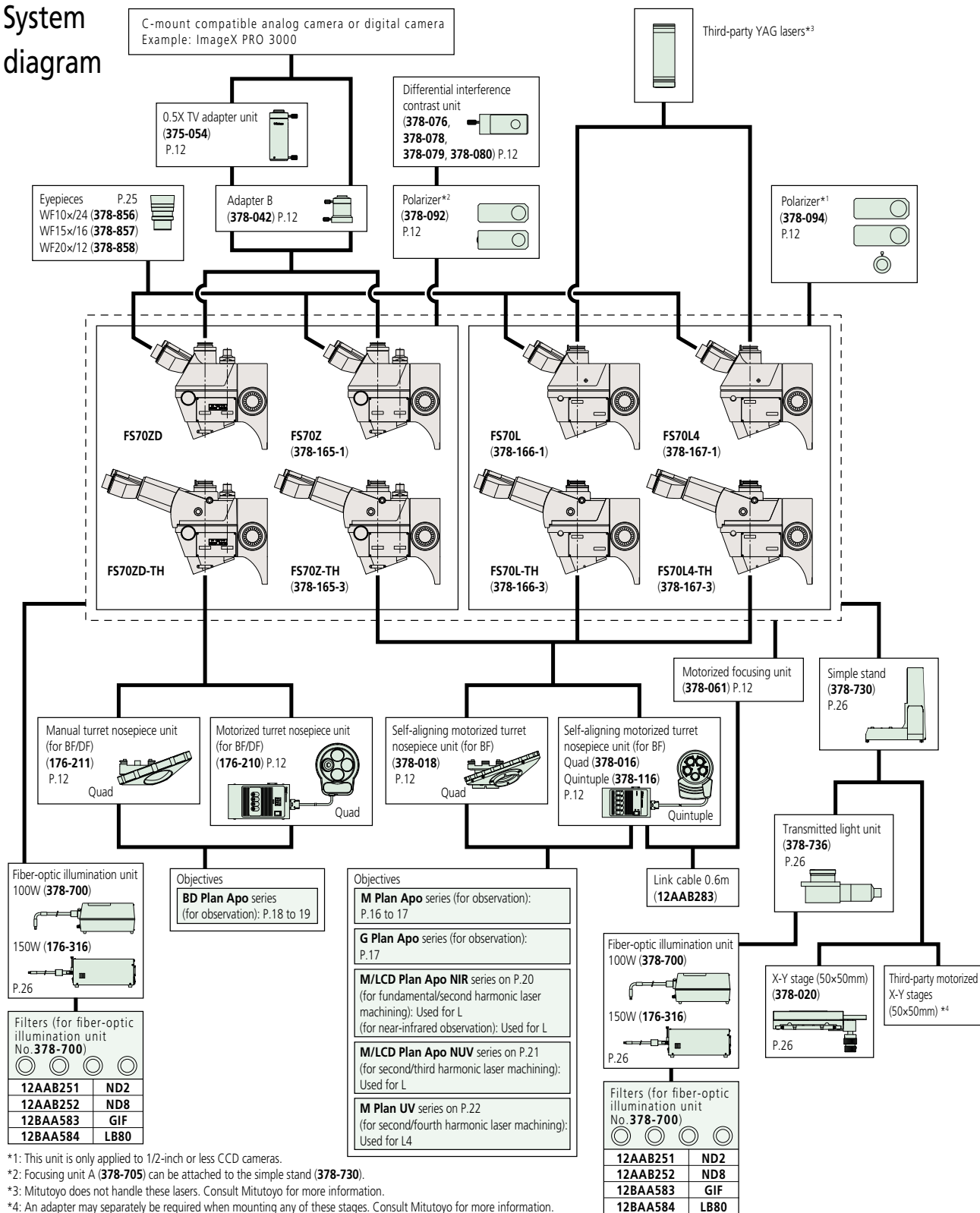
Specifications

Standard head type (w/short focus unit)		Model No.	FS70Z (FS70Z-S)	FS70ZD (FS70ZD-S)	FS70L (FS70L-S)	FS70L4 (FS70L4-S)
Order No.			378-165-1 (-2)	Made-to-order	378-166-1 (-2)	378-167-1 (-2)
Tilting head type		Model No.	FS70Z-TH	FS70ZD-TH	FS70L-TH	FS70L4-TH
Order No.			378-165-3	Made-to-order	378-166-3	378-167-3
Observation			BF/simplified polarized/DIC, erect image	BF/DF/simplified polarized/DIC, erect image	BF/simplified polarized, erect image	
Applicable eyepiece (optional)			10X (field number 24), 15X (field number 16), 20X (field number 12),			
Optical tube	Trinocular tube	Field number	24			
		Pupille distance	Siedentopf type, adjustment range: 51 to 76mm			
		Tilt angle	0 to 20°, displacement of eye point: 114mm (only for tilting head type)			
		Optical pass ratio	Eyepiece: Camera mount = 50%: 50% (fixed)		Eyepiece: Camera mount = 100%: 0% or 0%: 100% (switchable)	
	Camera mount	C-mount with parfocal adjustment* *In combination with an optional adapter B		C-mount with parfocal adjustment and green filter switch* *Only for FS70-L4, L4-S and L4-TH		
	Protective filter	—		Laser cutting filter		
	Tube lens (correction range)	1- 2X zoom (visible)		1X (NUV - visible - NIR)		1X (UV - visible)
Laser port	Optical features	—		Magnification: 1X λ: 355/532/1064μm	Magnification: 1X λ: 226/532μm	
	Suitable YAG laser type*2	—		Fundamental and second and third-harmonic waves	Second and fourth-harmonic waves	
Focus unit	Coarse/fine feed	Coaxial feeding knob (right and left), Coarse feed: 3.8mm/rev., Fine feed: 0.1mm/rev.				
	Travel range	50mm				
Suitable turret (optional)			4-mount manual or 5-mount power turret	4-mount manual or 4-mount power turret	4-mount manual or 5-mount power turret	
Suitable objective (optional)	For observation*1	M Plan Apo/HR/SL, G Plan Apo		BD Plan Apo/HR/SL	M Plan Apo/HR/SL, G Plan Apo	
	For laser cutting	—			M/LCD Plan Apo NIR, M/LCD Plan Apo NUV	M Plan UV
Optical system of illumination		Koehler reflective illumination with aperture diaphragm				
Fiber-optic illuminator (optional)		12V/100W (378-700D), 12V/150W (178-316D)				
Loading capacity of camera mount		Approx. 14kg (tilting head type: 13.2kg)			Approx. 13kg (tilting head type: 13.1kg)	
Mass (Dimension: Refer to page 28.)		6.6kg (tilting head type: 7.4kg)			6.7kg (tilting head type: 7.5kg)	
Mass		6.6kg (-TH: 7.4kg)			6.7kg (-TH: 7.5kg)	

*1: M Plan Apo 1x objective should be used together with the polarizer (378-092 or 378-094).

*2: When mounting a laser, ensure all safety precautions are observed and be aware of laser output power, beam energy density and the unit's weight. Please consult Mitutoyo if in doubt.

System diagram



*1: This unit is only applied to 1/2-inch or less CCD cameras.

*2: Focusing unit A (378-705) can be attached to the simple stand (378-730).

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

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

Optional Accessories for FS70

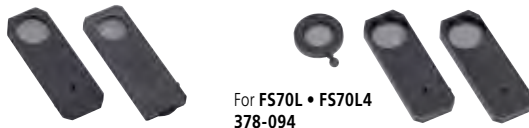
Manual turret



Order No.	378-018	378-211
Observation method	Bright field	Bright/dark field
No. of objective mounts	4, with centering and parfocal adjustment (378-018)	
View field adjustment	±0.5mm	—
Parfocal adjustment	±0.5mm	—
Mass	1.9kg	1.2kg

Polarizer

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

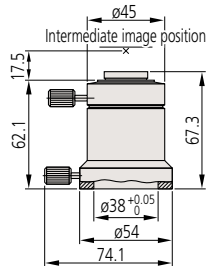
Used for differential interference contrast observation in conjunction with the polarizer.



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

Adapter B

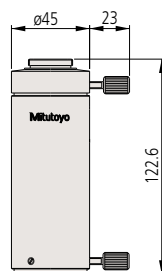
Used for mounting a C-mount camera.



378-042 Mass: 170g

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: ø11mm
Mass: 300g

Power turret



378-016

Console box

Order No.	378-116	378-016	378-210
Observation method	Bright field		Bright/dark field
No. of objective mounts	5, with centering adjustment	4	4
View field adjustment	±0.5mm		—
Positioning accuracy	2σ=3μm	—	—
Durability (life-time)	1 million repositioning operations	—	1 million repositioning operations
Drive method	DC motor		
Power supply	AC100V - 240V, 10W		
Output interface	RS-232C* for external PC control		
Cable length	3m		
Dimensions (WxHxD) and mass	Turret: 164x65x137mm, 1.4kg (378-116: 130x47x186mm, 1.8kg) Console box: 108x72x193mm, 810g (378-116: 108x63x176mm, 810g)		

*Optional RS-232C Cable: 12AAA807

Power focusing unit

This unit is provided with a handy console box that is capable of external PC control. The power focus device is also retrofitable for the focus unit A/B for VMU series.



Power focus device mounted on FS70Z with optional objectives

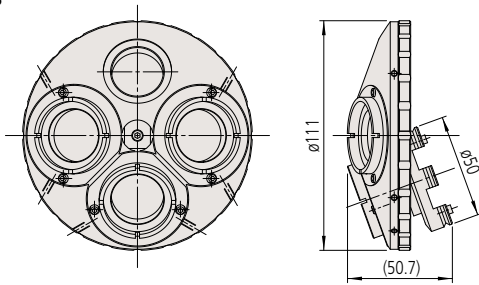
Order No.	378-061
Minimum travel	0.2μm
Feeding speed	1.6mm/sec
Driving method	Stepping motor, jog-shuttle controls
Power supply	AC100V - 240V, 6W
Output interface	RS-232C* for external PC control
Cable length	3m
Dimensions (WxHxD) and mass	Focus unit: ø69xL99mm, 620g Console box: 108x87x201mm, 2.4kg

*Optional RS-232C Cable: 12AAA807

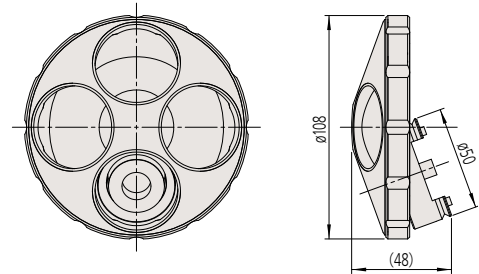
Dimensions of Optional Accessories for FS70

Manual turret

378-018

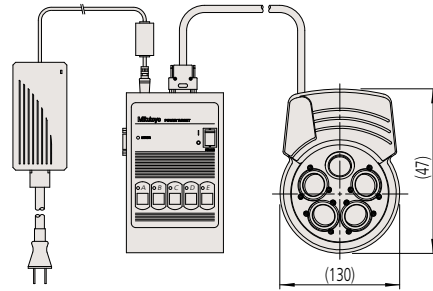


176-211

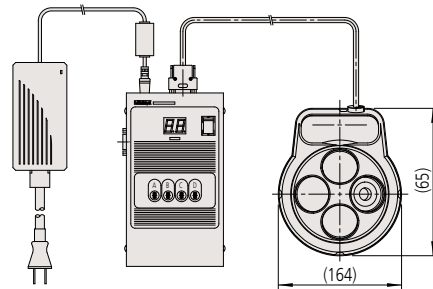


Power turret

378-116



176-210



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).

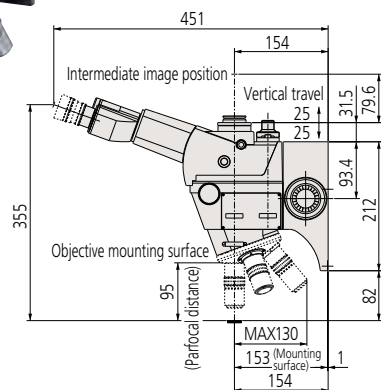
Suitable bright field objectives:

M Plan Apo/SL, G Plan Apo, M Plan Apo NIR, M Plan Apo NUV and M Plan UV

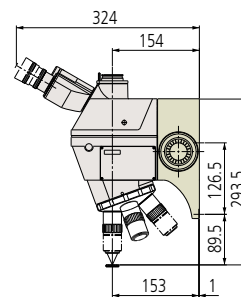
Focus point adjust shim set

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

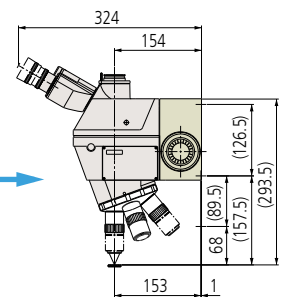
Tilting head type



Short focus unit type



Standard focusing unit mounting dimensions



Manual focusing unit S mounting dimensions

Zoom Video Microscope Unit VM-ZOOM



*Shown with optional stand and XY stage

Features

- > **Microscope unit with the high-zoom function**
Capable of continuous zooming from 100X to 4000X on a monitor (15").
- > **Equipped with a unique sliding turret, to which an additional objective (optional) for laser applications, as well as the standard high-resolution objective (M Plan Apo HR 10X), can be attached.**
- > **Compatible with YAG lasers (1064nm, 532nm, 355nm and 266nm)**
Available for cutting, trimming, repair and marking of IC wiring (Au, Al), removing and processing thin-film (insulating film) and repair of color filter (defects repair). Also ideal as the microscope unit of a prober station for semiconductor substrates.
- > **Compatible with infrared system**
Available for internal observation of silicon packages and spectral characteristics analysis using an infrared source and camera.
- > **Available for simplified polarized and differential interference contrast (DIC)*.** *Made-to-order
- > **Telecentric reflective illumination system with aperture diaphragm.**

Specifications

Without binocular unit type	Model No.	VMZ40M	VMZ40M-L	VMZ40R	VMZ40R-L	VMZ40R-L4
	Order No.	378-171	378-173	378-175	378-177	378-181
With binocular unit type	Model No.	VMZ40M-B	VMZ40M-BL	VMZ40R-B	VMZ40R-BL	VMZ40R-BL4
	Order No.	378-172	378-174	378-176	378-178	378-182
Radiation range	NUV - visible - NIR					UV - visible
Zoom type	Manual			Power drive		
Observation	BF, erect image	BF/DF/simplified polarized/DIC, erect image		BF/simplified polarized, erect image		
Main unit magnification	0.25X to 10X (zoom ratio: 40)					
Total magnification	100X to 4000X (when using standard 10X objective, 1/2" camera and 15" monitor)					
Observation range	1/2" camera: 2.56x1.92mm to 0.064x0.048mm, WF10X/24 eyepiece: ø3.2mm to ø0.08mm (when using standard 10X objective)					
Suitable eyepiece	10X (standard), 15X (optional), 20X (optional)					
Suitable objective	For observation	Standard: M Plan Apo HR 10X (NA: 0.42, WD: 15mm), Optional*: M Plan Apo, G Plan Apo				
	For laser working (optional)	—	M/LCD Plan Apo NIR, M/LCD Plan Apo NUV	—	M/LCD Plan Apo NIR, M/LCD Plan Apo NUV	M Plan UV
Focusing unit	Coarse/fine feed	Coaxial feeding knob (right and left), Coarse feed: 3.8mm/rev., Fine feed: 0.1mm/rev.				
	Travel range	50mm				
Turret	1-mount	2-mount with centering adjustment	1-mount	2-mount with centering adjustment	2-mount with centering adjustment	
Optical system of illumination	Koehler reflective illumination with aperture diaphragm					
Fiber-optic illuminator (optional)	12V/100W (378-700D), 12V/150W (178-316D)					
Camera mount	C-mount with centering and parfocal adjustment and green filter switch:* *Only for VMZ40R-L4 and BL4					
Suitable camera	1/2" or smaller camera (C-mount compatible)					
Mass, *with binocular unit type (Dimension: Refer to page 29.)	6.5kg/7.0kg*	7.5kg/8.0kg*	7.0kg/7.5kg*	8.0kg/8.5kg*	7.5kg (8.5kg)	

*1: Recommended magnification of objective: 2X to 50X

System diagram

VM-ZOOM40		
VMZ40M series	VMZ40R series	
Near-infrared/visible/near-ultraviolet light correction	Visible/ ultraviolet light correction	
Main unit	Main unit	Main unit (with laser port)
No illumination unit installed (optional)	Remote controller (with built-in illumination light source)	Remote controller (with built-in illumination light source)
Objective M Plan Apo HR 10x	Objective M Plan Apo HR 10x	Objective M Plan Apo HR 10x
Binocular tube (with eyepiece WF10x/24)	Binocular tube (with eyepiece WF10x/24)	Binocular tube (with eyepiece WF10x/24)
Laser port	Laser port	

Polarizer

For simplified polarized observation.



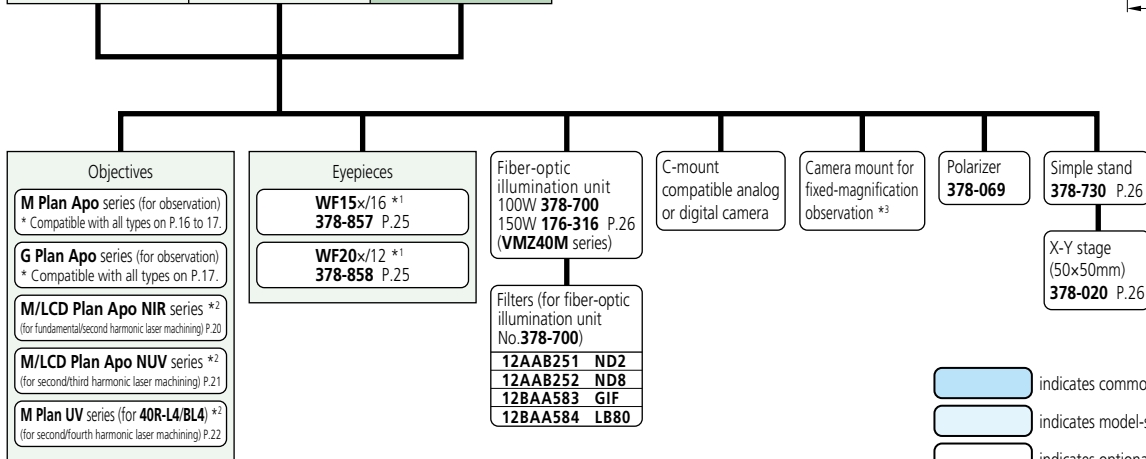
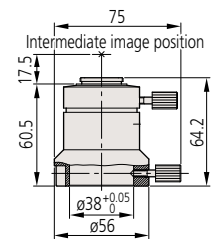
378-069
Mass: 115g

Camera mount

Can be attached to the laser mount for a dual-camera system. It is compatible with a 2/3" or smaller C-mount camera.



378-087
Mass: 180g



*1: Compatible with models equipped with a binocular tube.

*2: Compatible with **VMZ40□-□□□** types (models equipped with a YAG laser). These types are recommended to use an objective with a magnification of 20X or 50X.

*3: The current position of a workpiece being observed with a camera on the zoom side can be checked by using a laser optical system (with a built-in 1X tube lens).

This camera mount is compatible with **VMZ40□-□□□** types (models equipped with a YAG laser oscillator). Use a 2/3-inch or less analog or digital camera (with a C mount).

Objectives for Bright Field Observation (long working distance) M Plan Apo / M Plan Apo HR

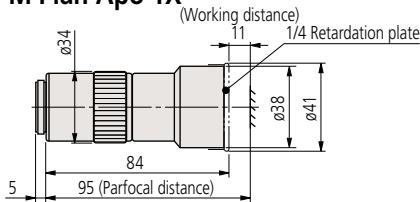
VMU FS70 MF-U Hyper MF-U FS300 FS110 VM-ZOOM

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

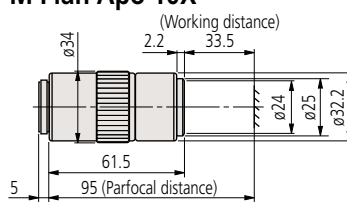


Dimensions

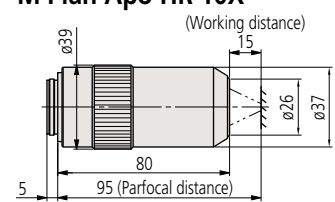
M Plan Apo 1X



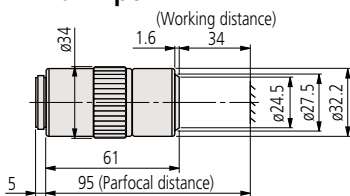
M Plan Apo 10X



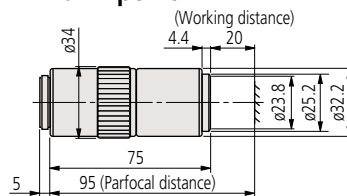
M Plan Apo HR 10X



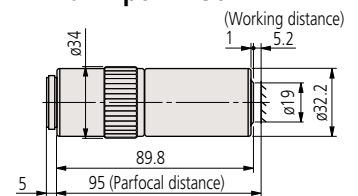
M Plan Apo 2X



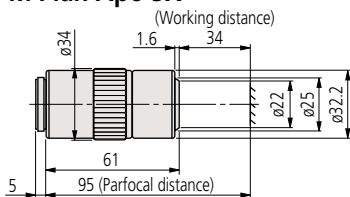
M Plan Apo 20X



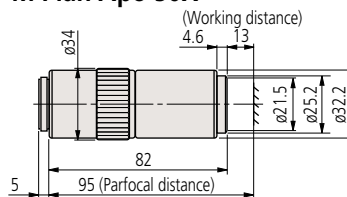
M Plan Apo HR 50X



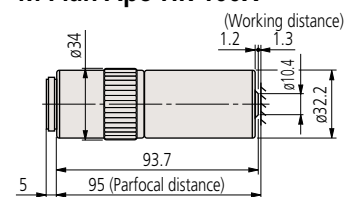
M Plan Apo 5X



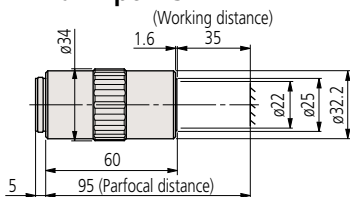
M Plan Apo 50X



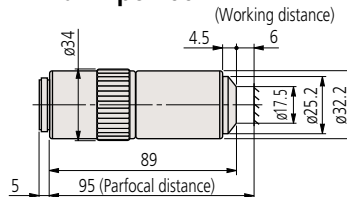
M Plan Apo HR 100X



M Plan Apo 7.5X



M Plan Apo 100X



Specifications

Order No.	Mag.	N.A.	W.D. (mm)	f (mm) (λ=550nm)	R (μm) (λ=550nm)	±DOF (μm)	Real FOV (mm)		Mass (g)
							ø24 eyepiece	1/2" camera	
378-800-3*1	1X	0.025	11.0	200	11.0	440	ø24	4.8x6.4	300
378-801-6*2	2X	0.055	34.0	100	5.0	91	ø12	2.4x3.2	220
378-802-6	5X	0.14	34.0	40	2.0	14.0	ø4.8	0.96x1.28	230
378-807-3	7.5X	0.21	34.0	26.67	1.3	6.2	ø3.6	0.64x0.85	240
378-803-3	10X	0.28	34.0	20	1.0	3.5	ø2.4	0.48x0.64	240
378-804-3	20X	0.42	20.0	10	0.7	1.6	ø1.2	0.24x0.32	270
378-805-3	50X	0.55	13.0	4	0.5	0.9	ø0.48	0.10x0.13	290
378-806-3	100X	0.70	6.0	2	0.4	0.6	ø0.24	0.05x0.06	320
378-788-4*3	10X	0.42	15.0	20	0.7	1.60	ø2.4	0.48x0.64	460
378-814-4	50X	0.75	5.2	4	0.4	0.49	ø0.48	0.10x0.13	400
378-815-4	100X	0.90	1.3	2	0.3	0.34	ø0.24	0.05x0.06	410

*1: It should be used together with an appropriate polarizer for the microscope used.

*2: It is recommended to be used together with the 1/4 wavelength plate A (02ALN370) and appropriate polarizer for the microscope used. (W.D.: 95.5mm, f: 30.0mm)

*3: The specifications of this objective are as in the use with VM-ZOOM.

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

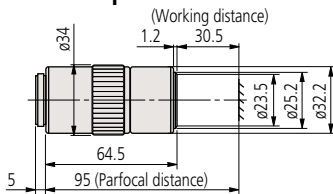
Objectives for Bright Field Observation (Ultra-long working distance) M Plan Apo SL

VMU FS70 MF-U Hyper MF-U FS300 FS110 VM-ZOOM

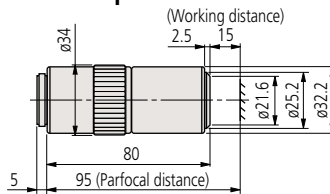
Features > Infinity corrected > Bright field observation > Ultra-long working distance > Plan-Apochromat

Dimensions

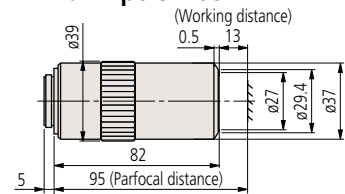
M Plan Apo SL20X



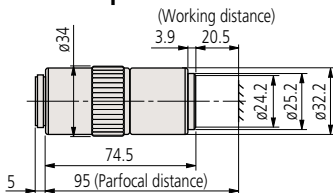
M Plan Apo SL80X



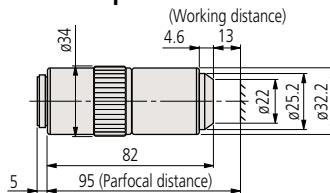
M Plan Apo SL200X



M Plan Apo SL50X



M Plan Apo SL100X



Specifications

Order No.	Mag.	N.A.	W.D. (mm)	f (mm) (λ=550nm)	R (μm) (λ=550nm)	±DOF (μm)	Real FOV (mm)		Mass (g)
							ø24 eyepiece	1/2" camera	
378-810-3	20X	0.28	30.5	10	1.0	3.5	ø1.2	0.24x0.32	240
378-811-3	50X	0.42	20.5	4	0.7	1.6	ø0.48	0.10x0.13	280
378-812-3	80X	0.50	15.0	2.5	0.6	1.1	ø0.3	0.06x0.08	280
378-813-3	100X	0.55	13.0	2	0.5	0.9	ø0.24	0.05x0.06	290
378-816-3	200X	0.62	13.0	1	0.4	0.7	ø0.12	0.025x0.03	490

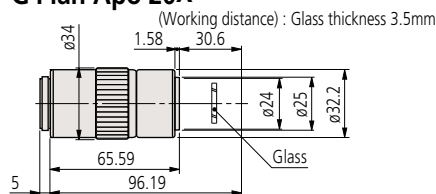
Objectives for Bright Field Observation (with glass-thickness compensation) G Plan Apo

VMU FS70 MF-U Hyper MF-U FS300 FS110 VM-ZOOM

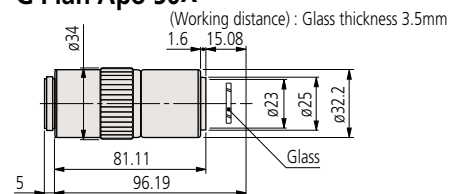
Features > Infinity corrected > Bright field observation > Ultra-long working distance > Plan-Apochromat
> Designed to observe a specimen through glass 3.5mm thick.

Dimensions

G Plan Apo 20X



G Plan Apo 50X



Specifications

Order No.	Mag./glass thickness (mm)	N.A.	W.D. (mm)	f (mm) (λ=550nm)	R (μm) (λ=550nm)	±DOF (μm)	Real FOV (mm)		Mass (g)
							ø24 eyepiece	1/2" camera	
378-847	20X/t3.5	0.28	29.42	10	1.0	3.5	ø1.2	0.24x0.32	270
378-848-3	50X/t3.5	0.50	13.89	4	0.6	1.1	ø0.48	0.10x0.13	320

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

Objectives for Bright/Dark Field Observation (long working distance) BD Plan Apo / BD Plan Apo HR

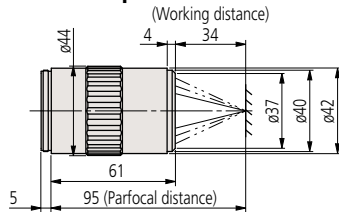
FS70 MF-U Hyper MF-U FS300 FS110

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

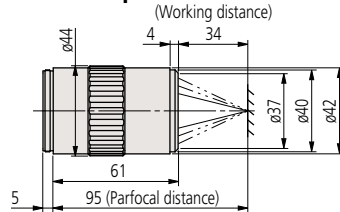


Dimensions

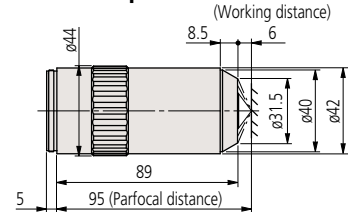
BD Plan Apo 2X



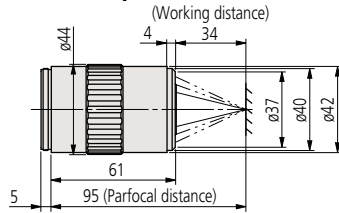
BD Plan Apo 10X



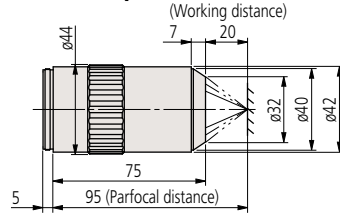
BD Plan Apo 100X



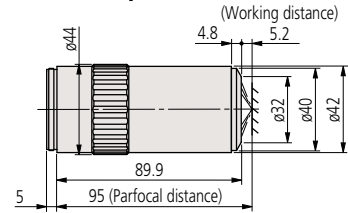
BD Plan Apo 5X



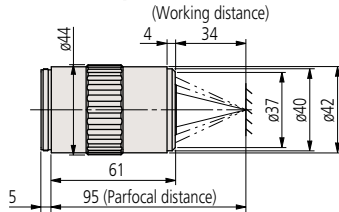
BD Plan Apo 20X



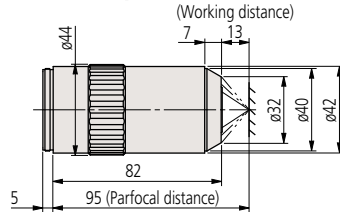
BD Plan Apo HR 50X



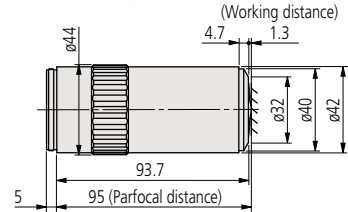
BD Plan Apo 7.5X



BD Plan Apo 50X



BD Plan Apo HR 100X



Specifications

Order No.	Mag.	N.A.	W.D. (mm)	f (mm) (λ=550nm)	R (μm) (λ=550nm)	±DOF (μm)	Real FOV (mm)		Mass (g)
							ø24 eyepiece	1/2" camera	
378-831-7*1	2X	0.055	34.0	100	5.0	91	ø12	2.4x3.2	340
378-832-7	5X	0.14	34.0	40	2.0	14.0	ø4.8	0.96x1.28	350
378-830-7	7.5X	0.21	34.0	26.67	1.3	6.2	ø3.6	0.64x0.85	350
378-833-7	10X	0.28	34.0	20	1.0	3.5	ø2.4	0.48x0.64	350
378-834-7	20X	0.42	20.0	10	0.7	1.6	ø1.2	0.24x0.32	400
378-835-7	50X	0.55	13.0	4	0.5	0.9	ø0.48	0.10x0.13	440
378-836-7	100X	0.70	6.0	2	0.4	0.6	ø0.24	0.05x0.06	460
378-845-7	50X	0.75	5.2	4	0.4	0.49	ø0.48	0.10x0.13	530
378-846-7	100X	0.90	1.3	2	0.3	0.34	ø0.24	0.05x0.06	545

*1: Recommended to be used together with the 1/4 wavelength plate A (02ALN380) and appropriate polarizer for the microscope used. (W.D.: 95.5mm, f: 30.0mm)
N.A.: Numerical aperture W.D.: Working distance f: Focal length R: Resolving power DOF: Depth of field FOV: Real field of view

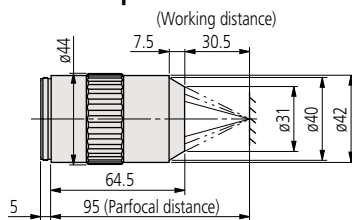
Objectives for Bright/Dark Field Observation (Ultra-long working distance) BD Plan Apo SL

FS70 MF-U Hyper MF-U FS300 FS110

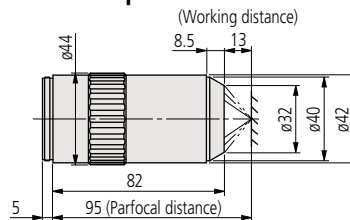
- Features**
- > Infinity corrected
 - > Bright/dark field observation
 - Suited to the to observation of scratches, concavity and convexity on a surface
 - > Ultra-long working distance
 - > Plan-Apochromat

Dimensions

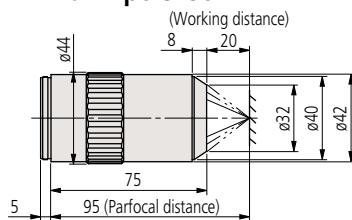
BD Plan Apo SL20X



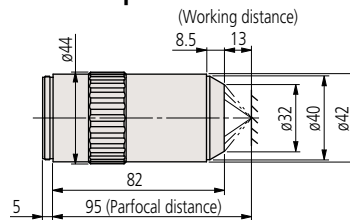
BD Plan Apo SL80X



BD Plan Apo SL50X



BD Plan Apo SL100X



Specifications

Order No.	Mag.	N.A.	W.D. (mm)	f (mm) (λ=550nm)	R (μm) (λ=550nm)	±DOF (μm)	Real FOV (mm)		Mass (g)
							ø24 eyepiece	1/2" camera	
378-840-7	20X	0.28	30.5	10	1.0	3.5	ø1.2	0.24x0.32	350
378-841-7	50X	0.42	20.5	4	0.7	1.6	ø0.48	0.10x0.13	410
378-842-7	80X	0.50	15.0	2.5	0.6	1.1	ø0.3	0.06x0.08	430
378-843-7	100X	0.55	13.0	2	0.5	0.9	ø0.24	0.05x0.06	440

Near-infrared radiation range objectives for bright field observation

M Plan Apo NIR

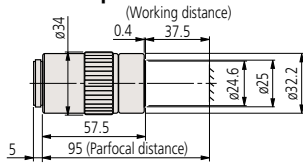
VMU FS70 FS300 FS110 VM-ZOOM



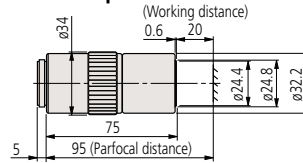
- Features**
- > Infinity corrected
 - > Suitable for bright field observation and laser applications
 - > Long working distance
 - > Plan-Apochromat
 - > Wavelength correction from visible to near-infrared (1800nm)
 - > Available high-power type (M Plan Apo NIR HR)

Dimensions

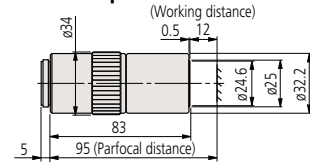
M Plan Apo NIR 5X



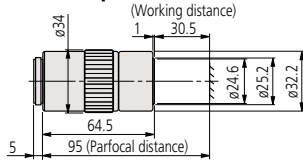
M Plan Apo NIR 20X



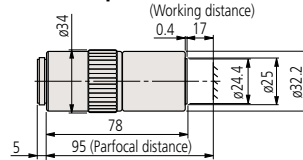
M Plan Apo NIR 100X



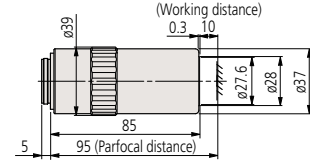
M Plan Apo NIR 10X



M Plan Apo NIR 50X



M Plan Apo NIR HR 50X/100X



Specifications

Note: If the wavelength used is 1100nm or longer, the focal point may deviate slightly from that in visible radiation.

Order No.	Mag.	N.A.	W.D. (mm)	f (mm) (λ=550nm)	R (μm) (λ=550nm)	±DOF (μm)	Real FOV (mm)		Mass (g)
							ø24 eyepiece	1/2" camera	
378-822-5	5X	0.14	37.5	40	2.0	14.0	ø4.8	0.96x1.28	220
378-823-5	10X	0.26	30.5	20	1.1	4.1	ø2.4	0.48x0.64	250
378-824-5	20X	0.40	20.0	10	0.7	1.7	ø1.2	0.24x0.32	300
378-825-5	50X	0.42	17.0	4	0.7	1.6	ø0.48	0.10x0.13	315
378-826-5	100X	0.50	12.0	2	0.6	1.1	ø0.24	0.05x0.06	335
378-863-5	50X	0.65	10.0	4	0.4	0.7	ø0.48	0.10x0.13	450
378-864-5	100X	0.70	10.0	2	0.4	0.6	ø0.24	0.05x0.06	450

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

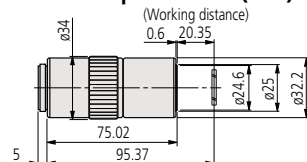
LCD Plan Apo NIR

VMU FS70 FS300 FS110 VM-ZOOM

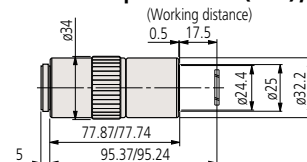
- Features**
- > Infinity corrected
 - > Suitable for bright field observation and laser applications
 - > Long working distance
 - > Plan-Apochromat
 - > Performance optimized for visible to near-infrared (1800nm) wavelengths
 - > Designed to observe a specimen through glass 1.1mm or 0.7mm thick.

Dimensions

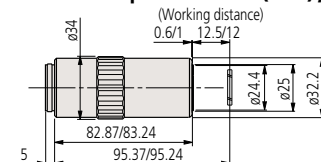
LCD Plan Apo NIR 20X (t1.1)



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



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



Specifications

Order No.	Mag./glass thickness (mm)	N.A.	W.D. (mm)	f (mm) (λ=550nm)	R (μm) (λ=550nm)	±DOF (μm)	Real FOV (mm)		Mass (g)
							ø24 eyepiece	1/2" camera	
378-827-5	20X/t1.1	0.40	19.98	10	0.7	1.7	ø1.2	0.24x0.32	305
378-829-5	50X/t0.7	0.42	17.26	3.9	0.7	1.6	ø0.48	0.10x0.13	320
378-725-5*	100X/t1.1	0.50	12.13	2	0.6	1.1	ø0.24	0.05x0.06	335
378-754-5	100X/t0.7	0.50	11.76	2	0.6	1.1	ø0.24	0.05x0.06	335

*Made-to-order

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



Near-ultraviolet radiation range objectives for bright field observation

M Plan Apo NUV

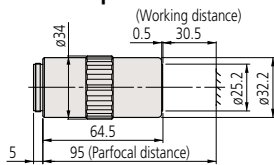
VMU FS70 VM-ZOOM



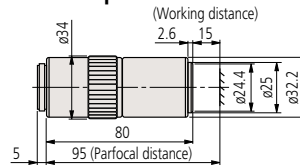
- Features**
- > Infinity corrected
 - > Suitable for bright field observation and laser applications
 - > Long working distance
 - > Plan-Apochromat
 - > Performance optimized for near-ultraviolet (355nm) to visible
 - > High-power type available (M Plan Apo NUV HR)

Dimensions

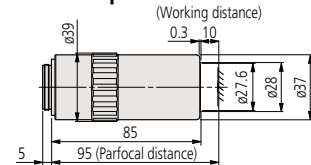
M Plan Apo NUV 10X



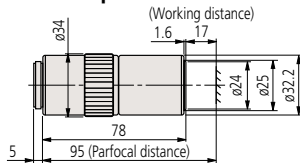
M Plan Apo NUV 50X



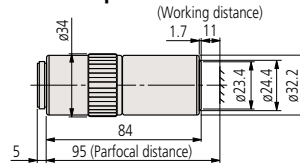
M Plan Apo NUV HR 50X



M Plan Apo NUV 20X



M Plan Apo NUV 100X



Specifications

Order No.	Mag.	N.A.	W.D. (mm)	f (mm) (λ=550nm)	R (μm) (λ=550nm)	±DOF (μm)	Real FOV (mm)		Mass (g)
							ø24 eyepiece	1/2" camera	
378-809-5	10X	0.28	30.5	20	1	3.5	ø2.4	0.48x0.64	255
378-817-4	20X	0.40	17.0	10	0.7	1.7	ø1.2	0.24x0.32	340
378-818-4	50X	0.42	15.0	4	0.7	1.6	ø0.48	0.10x0.13	350
378-819-4	100X	0.50	11.0	2	0.6	1.1	ø0.24	0.05x0.06	380
378-888-4	50X	0.65	10.0	4	0.42	0.65	ø0.48	0.10x0.13	500

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

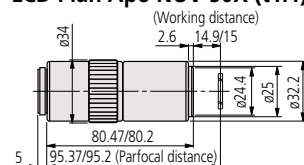
LCD Plan Apo NUV

VMU FS70 VM-ZOOM

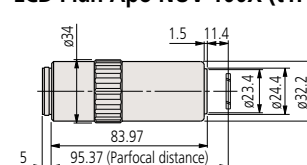
- Features**
- > Infinity corrected
 - > Suitable for bright field observation and laser applications
 - > Long working distance
 - > Plan-Apochromat
 - > Wavelength correction from near-ultraviolet (355nm) to visible
 - > Designed to observe a specimen through glass 1.1mm or 0.7mm thick.

Dimensions

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



LCD Plan Apo NUV 100X (t1.1)



Specifications

Order No.	Mag./glass thickness (mm)	N.A.	W.D. (mm)	f (mm) (λ=550nm)	R (μm) (λ=550nm)	±DOF (μm)	Real FOV (mm)		Mass (g)
							ø24 eyepiece	1/2" camera	
378-753-4*	50X/t1.1	0.42	14.53	4	0.7	1.6	ø0.48	0.10x0.13	310
378-820-4	50X/t0.7	0.42	14.76	4	0.7	1.6	ø0.48	0.10x0.13	310
378-751-4*	100X/t1.1	0.50	11.03	2	0.6	1.1	ø0.24	0.05x0.06	380

*Made-to-order

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

Ultraviolet radiation range objectives for bright field observation

M Plan UV

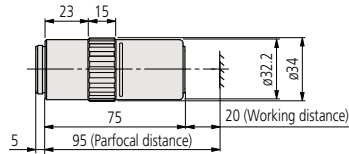
VMU FS70 VM-ZOOM

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

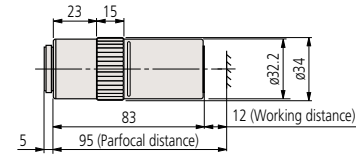


Dimensions

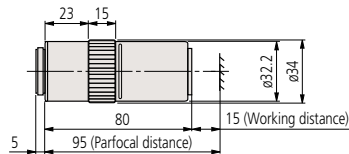
M Plan UV 10X



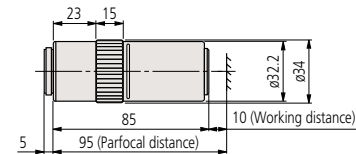
M Plan UV 50X



M Plan UV 20X



M Plan UV 80X



Specifications

Order No.	Mag.	N.A.	W.D. (mm)	f (mm) (λ=266nm)	f (mm) (λ=550nm)	R (μm) (λ=550nm)	±DOF (μm)	Real FOV (mm)		Mass (g)
								ø24 eyepiece	1/2" camera	
378-844-5	10X	0.25	20.0	20	20.3	1.1	4.4	ø2.4	0.48x0.64	310
378-837-5	20X	0.36	15.0	10	10.4	0.8	2.1	ø1.2	0.24x0.32	330
378-838-5	50X	0.40	12.0	4	4.5	0.7	1.7	ø0.48	0.10x0.13	400
378-839-5	80X	0.55	10.0	2.5	2.9	0.5	0.9	ø0.3	0.05x0.08	380

Note: 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 ($\lambda=266$ nm) is slightly smaller than that in visible radiation ($\lambda=550$ nm) as above, the working area in ultraviolet radiation also becomes slightly smaller than the mask image in visible radiation.

Reference: Transmission of Mitutoyo Objectives

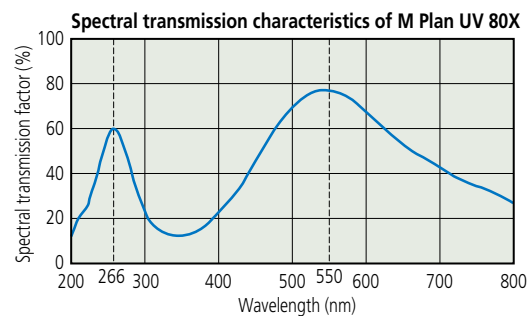
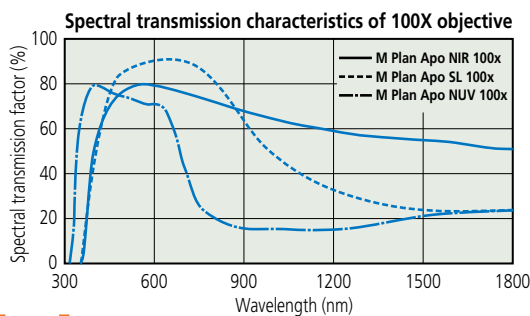
Mitutoyo's long working-distance objectives are grouped by working wavelength range: ultraviolet, near-ultraviolet, visible, and near-infrared. The M Plan UV series (for ultraviolet), M Plan Apo NUV series (for near-ultraviolet), and M Plan Apo NIR series (for near-infrared) are designed especially for 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 436nm to 656nm

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

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

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



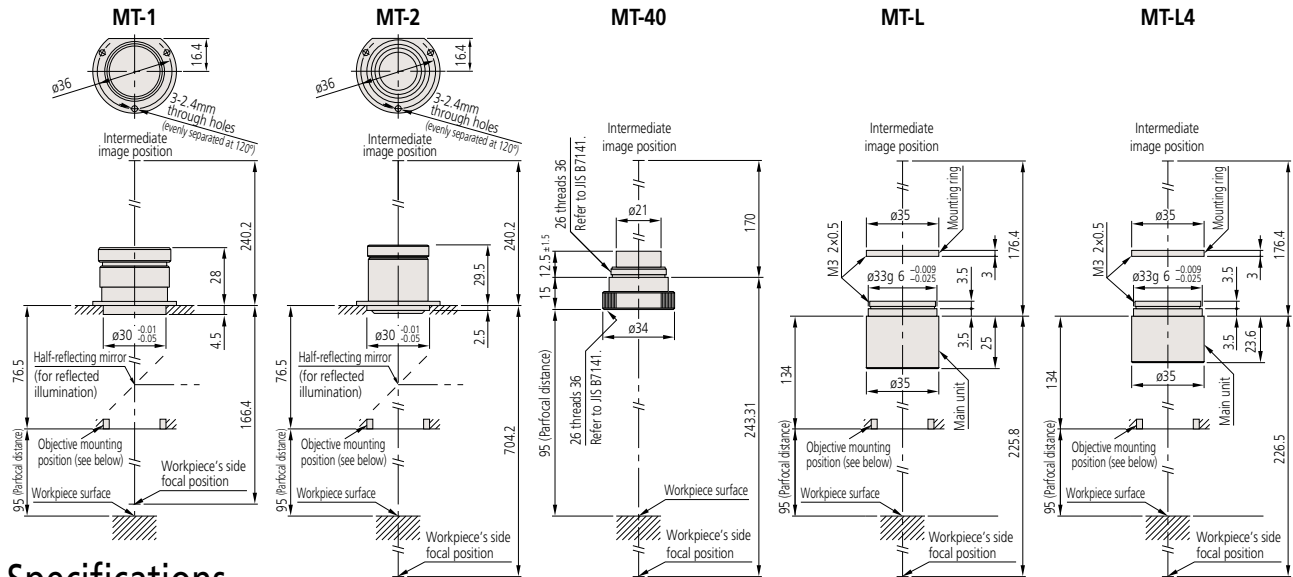
N.A.: Numerical aperture W.D.: Working distance f: Focal length R: Resolving power DOF: Depth of field FOV: Real field of view

Tube Lens MT

Aberration correction range

MT-1, 2, 40: Visible wavelength range (435.8 – 656.3nm)
MT-L: Near-ultraviolet (355nm) to near-infrared (1064nm)
MT-L4: Ultraviolet (266nm) to visible (620nm).

Dimensions



Specifications

Order No.	Focal length (mm)	Magnification (tube lens)	Image field (mm)	Effective lens dia. (mm)	Dimensions (mm)	Mass (g)
970208	200	1X	ø30	ø24.0	ø40x32.5	43
970209	400	2X	ø30	ø18.0	ø40x32.0	42
378-010	200	1X	ø24	ø11.2	ø34x27.5	45
378-008	200	1X	ø24	ø22.0	ø35x32.0	30
378-009	200	1X	ø24	ø23.0	ø35x30.6	30

Note: A distance of 76.5mm in 970208 and 970209 drawings is for an image field of ø30 (without vignetting). For an image field of ø24 or ø11 (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 ø30mm (ø24mm), 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:

$$\ell = (\sigma_2 - \sigma_1) \cdot f_2 / \sigma \quad (1) \quad \begin{array}{l} \sigma_1 : \text{Objective exit pupil diameter (mm)} \\ \sigma_2 : \text{Effective diameter of tube lens (mm)} \\ f_2 : \text{Focal length of tube lens} \\ \sigma : \text{Image field diameter} \end{array}$$

$$\sigma_1 = 2 \cdot f \cdot \text{N.A.} \quad (2)$$

Example: What is the distance (L), when using **M Plan Apo 10X*** (**378-803-3**) and tube lens** (**970208**) to cover an image field of ø24?

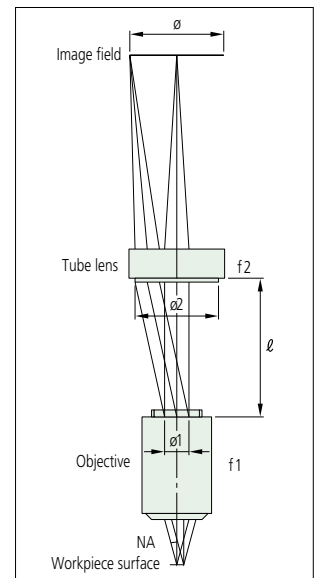
*f=20mm, N.A.=0.28 (Refer to page 15.) **σ₂=24mm, f₂=200mm (Refer to the above chart.)

$$\text{From formula (2): } \sigma_1 = 2 \times 20 \times 0.28 = 11.2 \text{ (mm)}$$

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

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

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



Objectives for Measuring Microscopes

ML

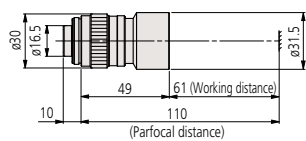
MF Hyper MF



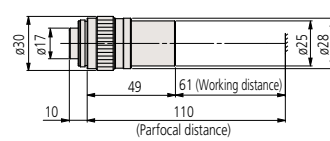
Features > Finite-correction (image-object distance: 280mm, parfocal length: 110mm)
> Bright field observation > Long working distance > Telecentric for lenses lower than 10X magnification

Dimensions

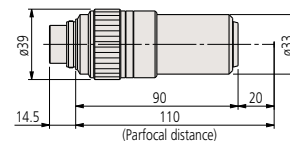
ML 1X



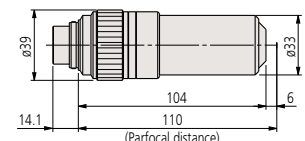
ML 5X



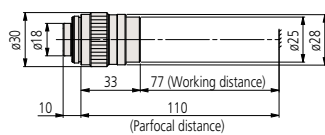
ML 20X



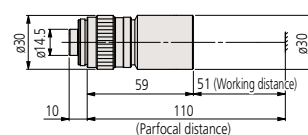
ML 100X



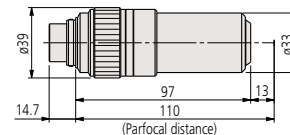
ML 3X



ML 10X



ML 50X



Specifications

Order No.	Mag.	N.A.	W.D. (mm)	R (μm) (λ=550nm)	±DOF (μm)	Real FOV (mm)		Mass (g)
						ø24 eyepiece	1/2" camera	
375-036-2	1X	0.03	61.0	9.2	306	ø24	4.8x6.4	80
375-037-1	3X	0.09	77.0	3.06	34	ø8	1.6x2.1	55
375-034-1	5X	0.13	61.0	2.12	16.3	ø4.8	0.96x1.28	60
375-039	10X	0.21	51.0	1.31	6.2	ø2.4	0.48x0.64	95
375-051	20X	0.42	20.0	0.65	1.6	ø1.2	0.24x0.32	310
375-052	50X	0.55	13.0	0.5	0.9	ø0.48	0.10x0.13	350
375-053	100X	0.70	6.0	0.4	0.6	ø0.24	0.05x0.06	380

Objectives for Centering Microscopes

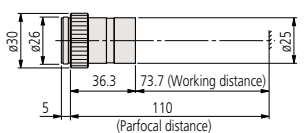
CF

CF

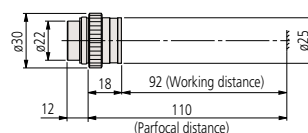
Features > Finite-correction (image-object distance: 280mm, parfocal length: 110mm)
> Bright field observation > Long working distance > Available zoom type

Dimensions

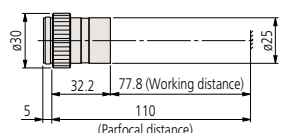
CF 1X



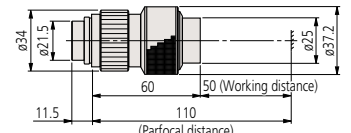
CF 2X



CF 3X



CF Zoom 1X - 5X



Specifications

Order No.	Mag.	N.A.	W.D. (mm)	R (μm) (λ=550nm)	±DOF (μm)	Real FOV (mm)		Mass (g)
						ø24 eyepiece	1/2" camera	
375-031	1X	0.03	73.7	9.2	306	ø24	4.8x6.4	45
375-032	2X	0.06	92.0	4.6	76	ø12	2.4x3.2	35
375-033	3X	0.07	77.8	3.9	56	ø8	1.6x2.1	35
375-038 (zoom lens)	1X	0.04	50.0	6.9	171	ø24	4.8x6.4	200
	3X	0.1		2.75	27	ø8	1.6x2.1	
	5X	0.1		2.75	27	ø4.8	0.96x1.28	



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

Wide Field of View Eyepieces and Reticles

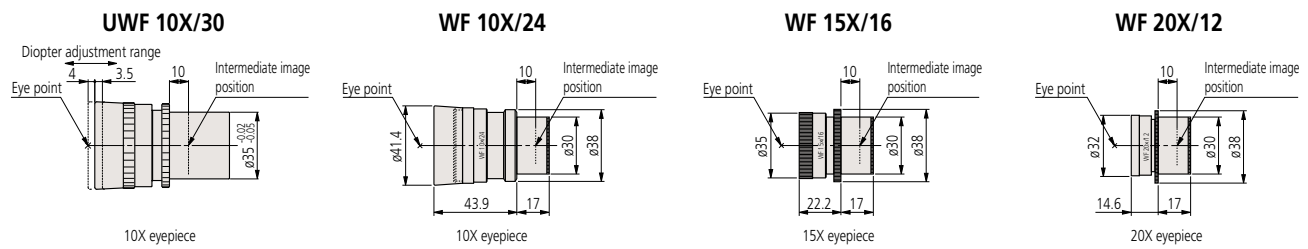
WF / UWF

MF MF-U Hyper MF Hyper MF-U FS70 FS300 FS110



- Features**
- > Wide field of view, especially the UWF 10X type (30 field number)
 - > External focusing system* allows installing an optional reticle. *Except for UWF 10X

Dimensions



Specifications

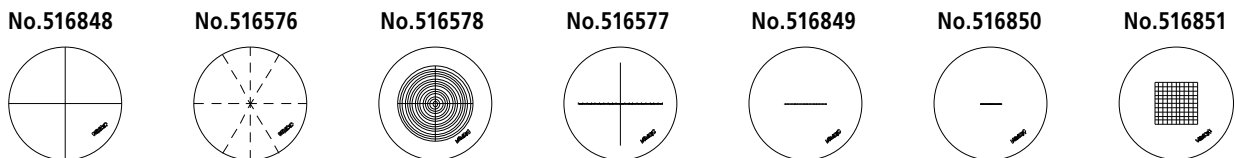
Order No. (2pcs.)	Magnification	Field number	Visibility adjustment	Eye point	Reticle	Mass (g)
378-851	10X	30	-8D to +4D	High eye point	—	250
378-856	10X	24	-10D to +5D	High eye point	Available	45
378-857	15X	16	-8D to +5D	Normal	Available	35
378-858	20X	12	-8D to +5D	Normal	Available	35

Reticles

FS70 FS300 FS110

- Features**
- > Fitted to the eyepiece at the intermediate image position for simple measurement. *Not available for UWF 10X
 - > Outside diameter of 25mm and thickness of 1mm
 - > Reticle line widths: 10 μ m (516577: 7 μ m)

Dimensions



Specifications

Order No.	516848	516576	516578	516577	516849	516850	516851
Remarks	90° full lines	90°, 60° chain lines	Crosshairs, one line graduated (P=0.1/20mm)	Concentric circles with crosshairs (P= $\phi 1.2/\phi 1.2$ - 18mm)	Graduation marks (P=0.1/10mm)	Graduation marks (P=0.05/5mm)	Grids (P=1mm/10mm square)

Optional Accessories for VMU, FS70 and VM-ZOOM

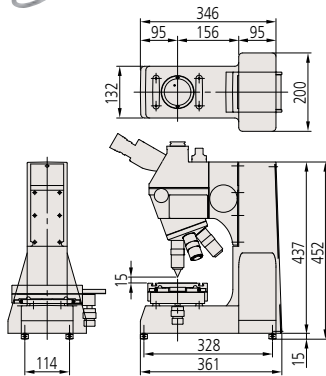
Stand

For mounting the VMU, FS70, or VM-ZOOM 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.

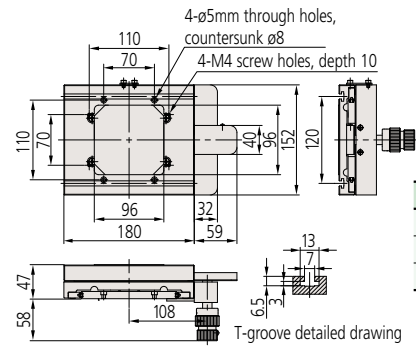


Order No.	378-730
Mass	6.7kg

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



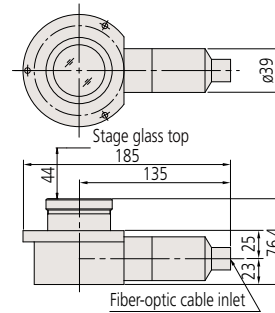
XY stage



Order No.	378-020
Travel range	50x50mm
Handle feed	34mm/rev.
Mass	3.3kg

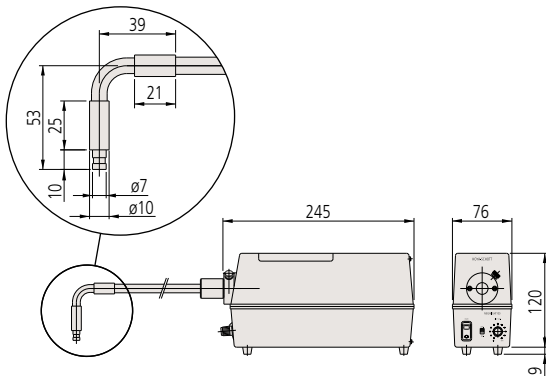
Stage illumination unit

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



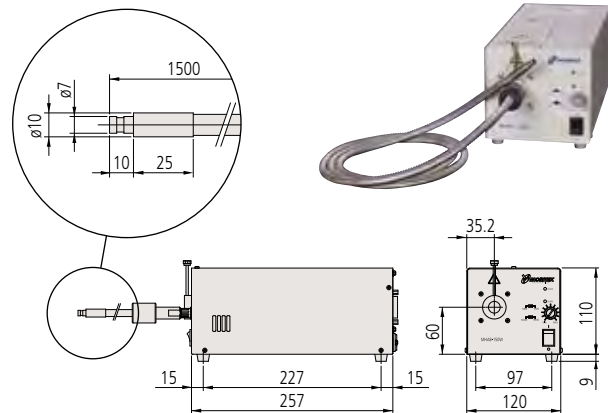
Order No.	378-736
Mass	0.8kg

Fiber-optic illuminator (100W)



Order No.	378-700D
Light source	12V/100W parabolic-type halogen bulb (517181), 100h service life
Light guide	Fiber-optic cable (1.5m length, 5mm dia.)
Brightness	Adjustable by volumn
Filter (optional)	LB80 Color temperature conversion filter (12BAA584)
	ND2 For 1/2 light intensity (12AAB251)
	ND8 For 1/8 light intensity (12AAB252)
	GIF Green filter (12BAA253)

Fiber-optic illuminator (150W)

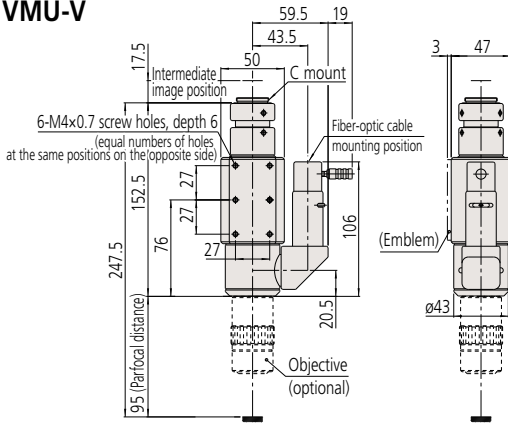


Order No.	176-316D	
Light source	Long-life type	15V/100W parabolic-type halogen bulb (12BAJ076), 500h service life
	High-brightness type	15V/100W parabolic-type halogen bulb (12BAJ075), 50h service life
Light guide	Fiber-optic cable (1.5m length, 5mm dia.)	
Brightness	Adjustable by rotary control	

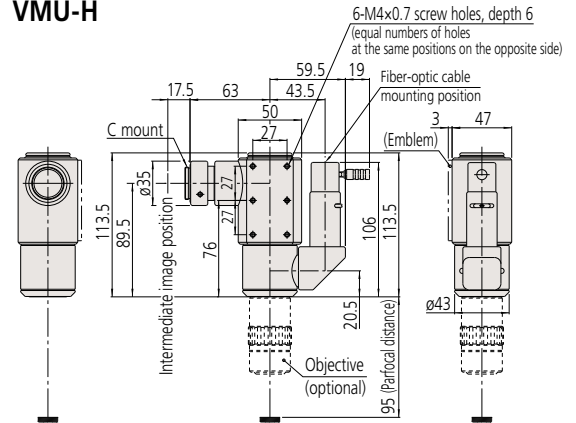
Dimensions

VMU series

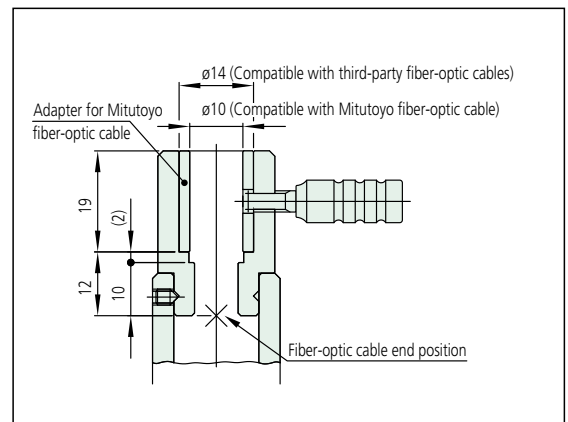
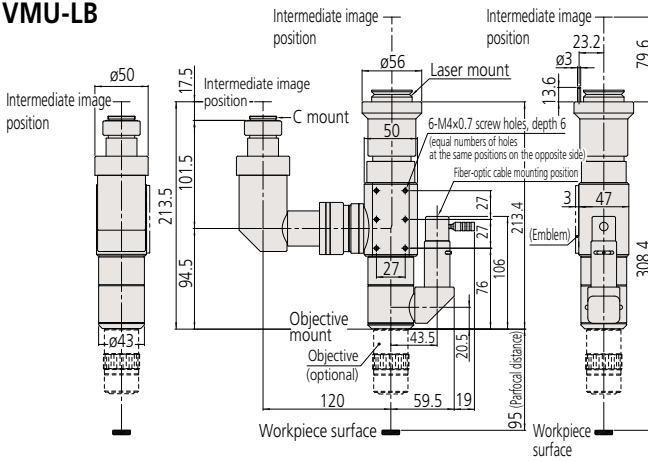
VMU-V



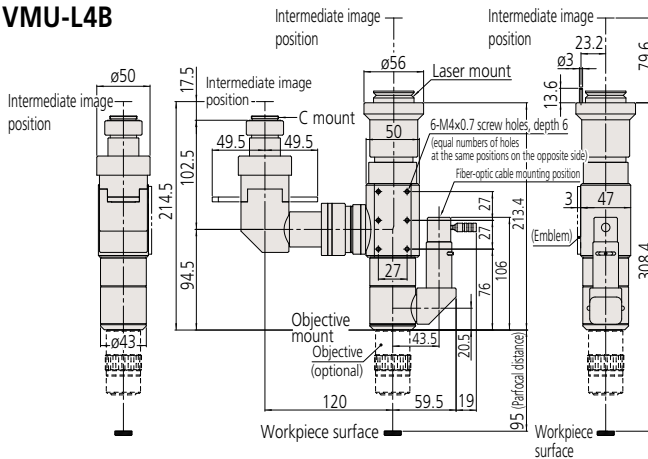
VMU-H



VMU-LB

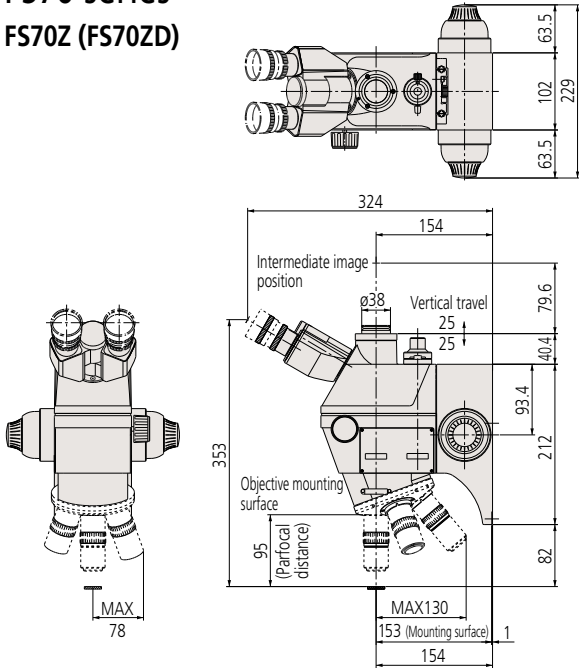


VMU-L4B

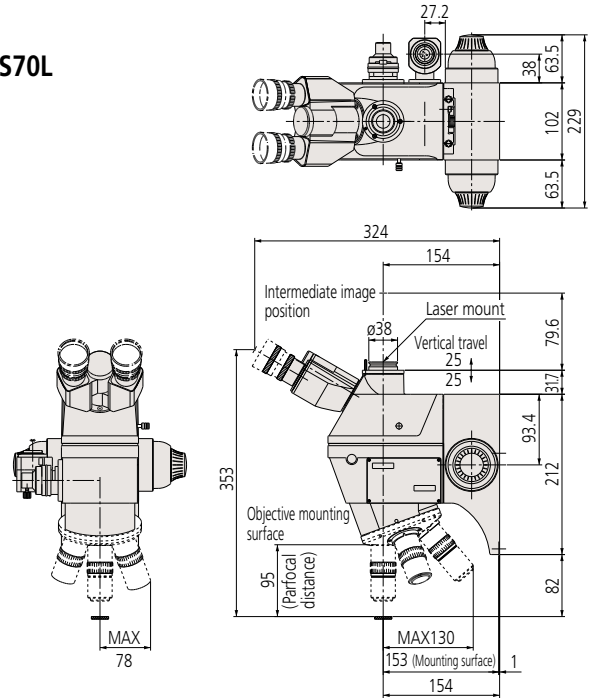


Dimensions

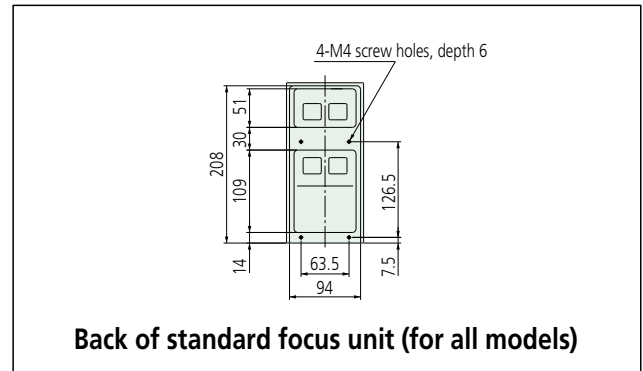
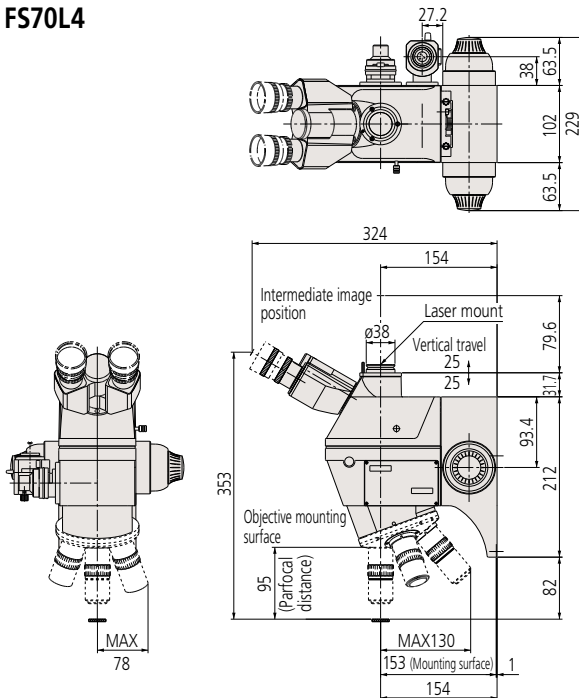
FS70 series FS70Z (FS70ZD)



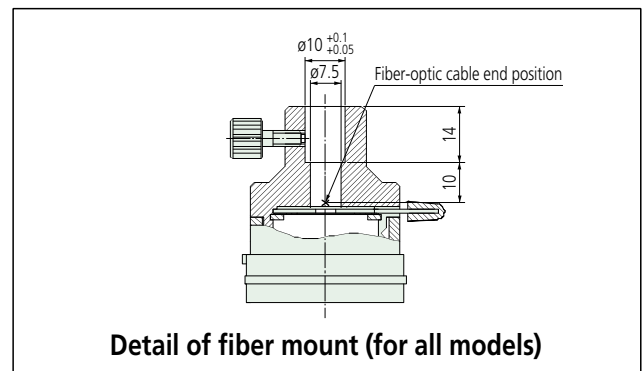
FS70L



FS70L4



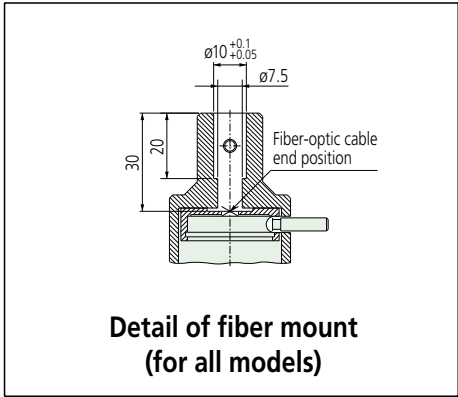
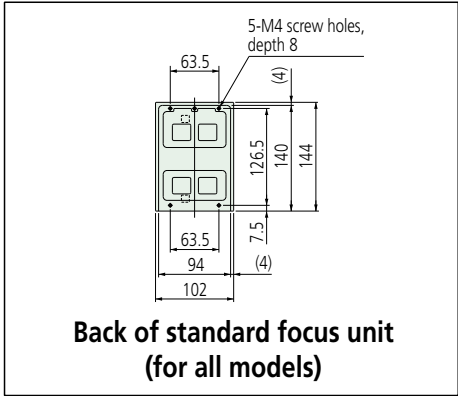
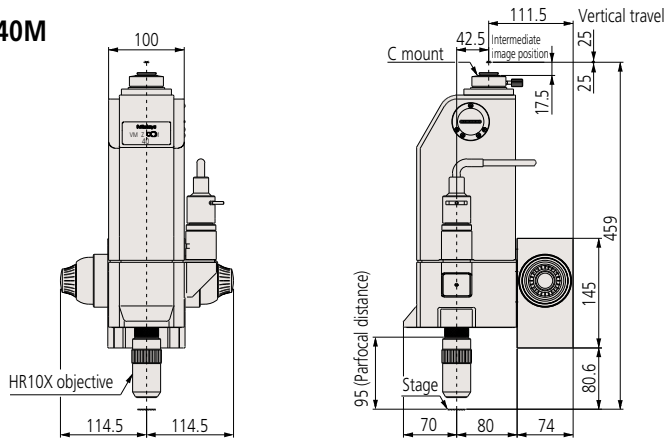
Back of standard focus unit (for all models)



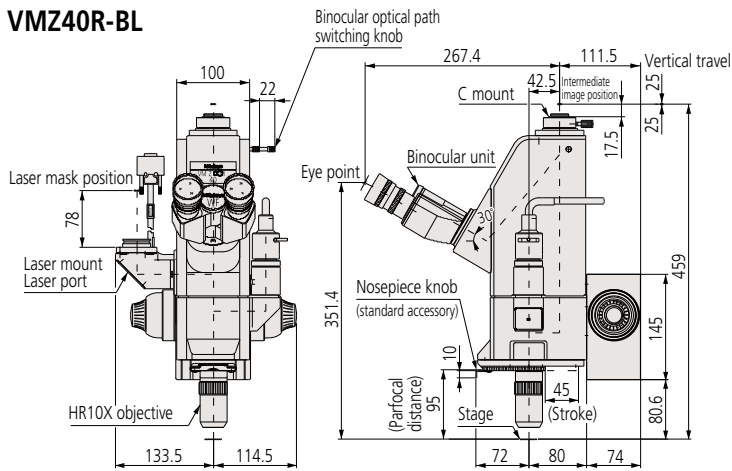
Detail of fiber mount (for all models)

VM-ZOOM series

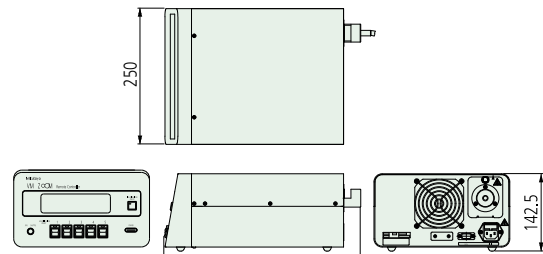
VMZ40M



VMZ40R-BL

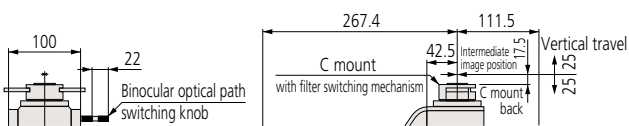


Remote Controller

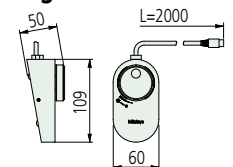


VMZ40R-BL4 (camera mount position)

Other dimensions except for camera mount are same as those for VMZ40R-BL.



Jog shuttle



Glossary

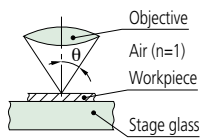
1. N.A. (Numerical Aperture)

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 .

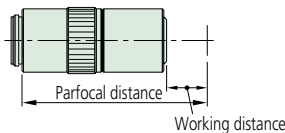
$$R (\mu m) = \frac{\lambda}{2 \cdot N.A.}$$

3. W.D. (Working distance)

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

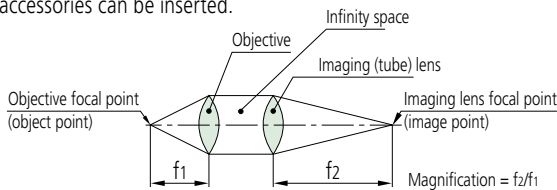
4. Parfocal Length

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



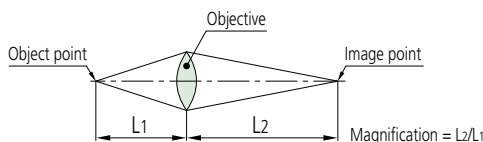
5. Infinity-corrected system

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.



7. F (Focal Length)

Distance between a principal point and a focal point. f^1 is a focal length of an objective, f^2 is a 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.)

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

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

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.

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

(Ex. Using an eyepiece of field number 24)

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

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

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

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

* Size of camera image element (V x H x Diagonal)

1/3 inch image element: 3.6x4.8x6.0mm 1/2 inch image element: 4.8x6.4x8.0mm

2/3 inch image element: 6.6x8.8x11.0mm

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 of Berek)

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

ω : Resolution of human eye (Visual angle: 5 minute)

M : Total magnification (Objective mag. x Eyepiece mag.)

TV monitor observation

$$\pm \text{DOF} (\mu m) = \frac{\lambda}{2 \times (N.A.)^2} \quad \lambda = 550 \text{ nm (Standard wavelength)}$$

10. Bright field illumination and dark field illumination

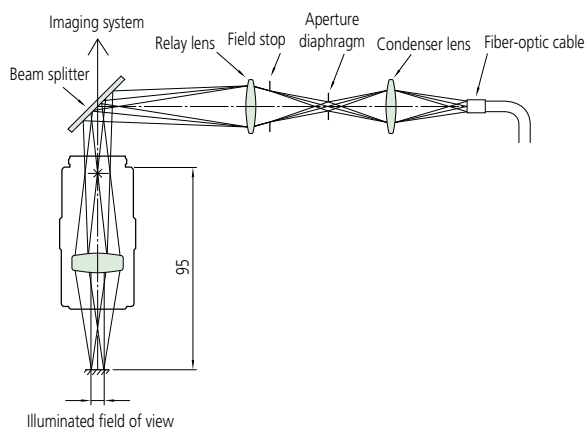
Bright field illumination directly lights the specimen with a solid cone of rays and is the simplest method available. Dark field illumination uses a hollow cone of rays formed by an opaque stop at the center of the condenser large enough to prevent direct light from entering the objective. The specimen 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

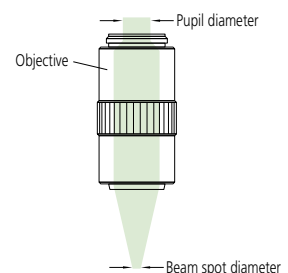
An image degrading a phenomenon in which an image appears as if it is a double image due to redundant light projection and optical interference within the optical system.

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.

$$\varnothing_{mm} = 2 \times N.A. \times f$$



• Spot diameter

If a beam of light with a uniformly distributed intensity enters an objective from the rear, the beam is condensed 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.

$$\varnothing_{\mu m} = 1.22 \times \frac{\lambda}{N.A.}$$

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.

$$\varnothing_{\mu m} = \frac{4\lambda \lambda f}{\pi x D}$$



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Mitutoyo Corporation

20-1, Sakado 1-Chome,
Takatsu-ku, Kawasaki-shi
Kanagawa 213-8533, Japan
T +81 (0)44 813-8230
F +81 (0)44 813-8231
<http://www.mitutoyo.co.jp>

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