

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





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](http://elfe.miyakyo-u.ac.jp/opac/2008/03/cd_2.html))



# A wealth of Applications

## System with digital camera



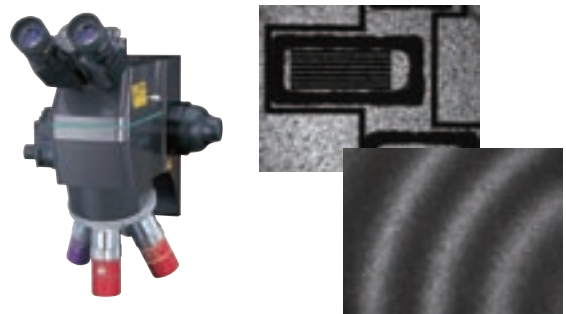
Digital microscopic system using VMU-V

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.

- > 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



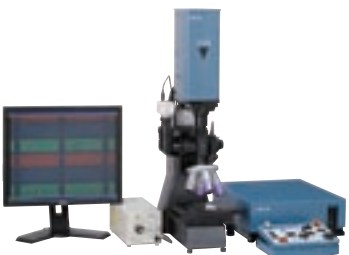
UV laser application using VMU-L4B  
(Source of photographs: V-Technology Co.,Ltd.)



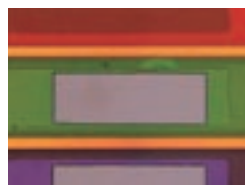
Flaking of polyimide membrane



SEM photograph of IC surface  
after removing upper layer



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

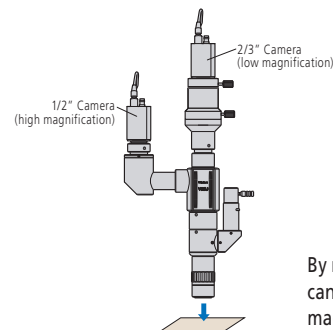


Color filter working

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

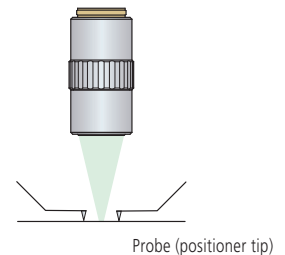
- > Peeling off protective films and organic thin-films
- > Cutting of IC wiring (Au, Al) and exposure of lower layer pattern
- > FPD defects repair
- > Photomask repair
- > Marking, trimming, patterning, spot annealing and scribing

## 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



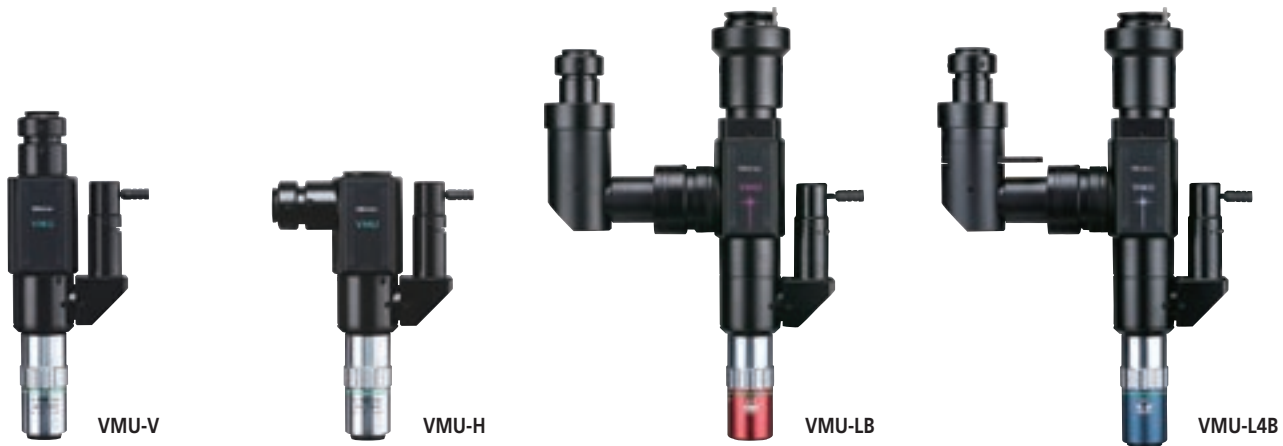
The Mitutoyo M Plan Apo objectives provide a long working distance. This allows you to design an optical system for defects evaluation of semiconductor integrated circuits and precise repair with YAG lasers. The optical system for direct observation is also available.



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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).**

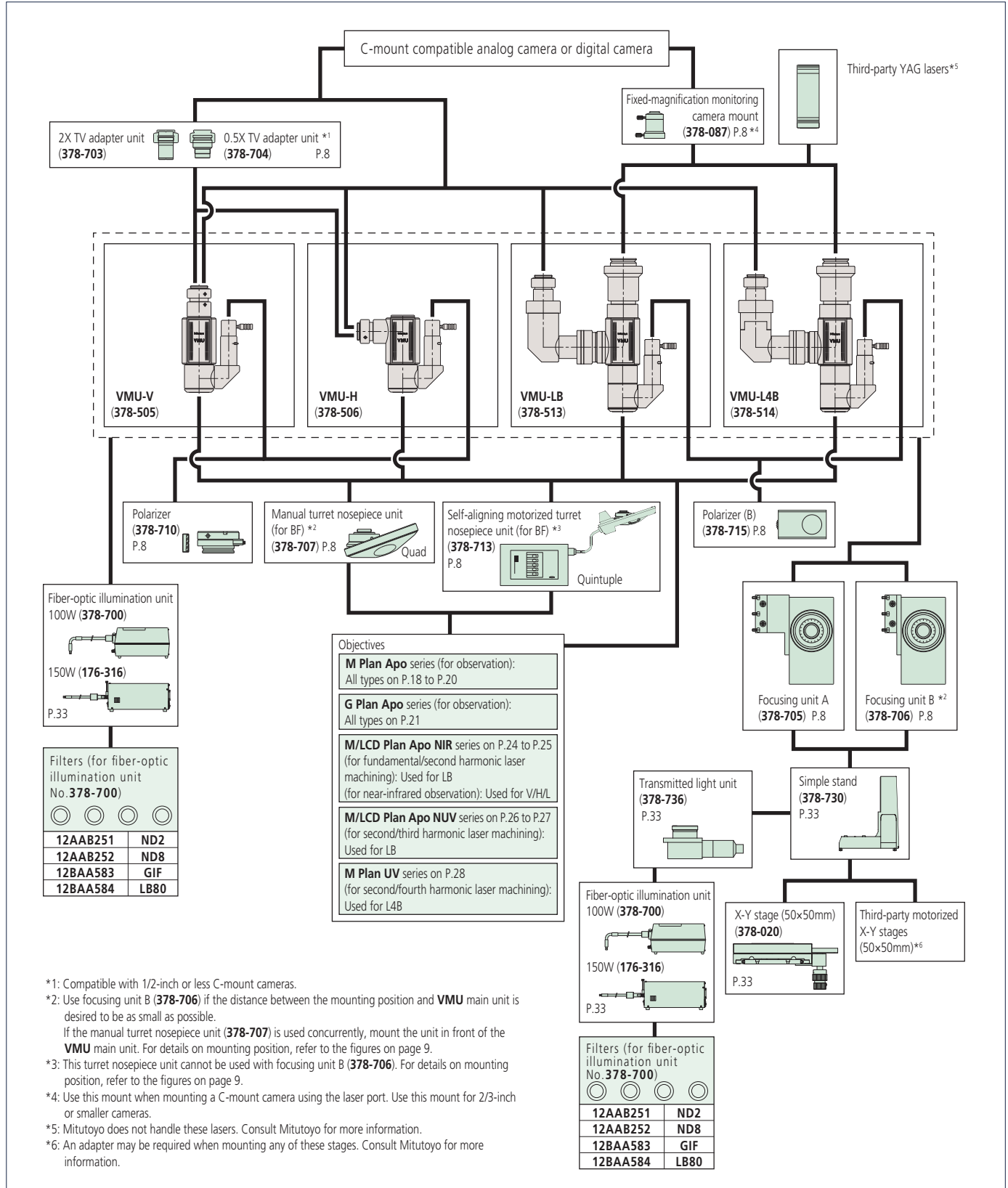
## Specifications

| 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 (centering and parfocal adjustment)                            |  |   |  |
|                                      | Mount                        | C-mount with centering and parfocal adjustment and green filter switch |  |   |  |
|                                      | Tube lens (correction range) | 1X (visible - NIR)   |  | 1X (NUV - visible - NIR)                                | 1X (UV - visible - NIR)                    |
|                                      | Laser port                   | Optical features   | —  | Magnification: 1X<br>λ: 355/532/1064μm                  | Magnification: 1X<br>λ: 226/355/532/1064μm |
| Polarizer*1                          | Mount                        | —  | With parfocal adjustment                         |   |  |
|                                      | Suitable YAG laser type*2    | —  | Fundamental, second and third-harmonic mode      | Fundamental and second, third and fourth-harmonic mode  |  |
|                                      | 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,<br>M/LCD Plan Apo NUV        | M/LCD Plan Apo NIR,<br>M/LCD Plan Apo NUV,<br>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



# 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.               | <b>378-707</b> |
| 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.        | <b>378-705</b>                       | <b>378-706</b> |
| 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.       | <b>378-703</b>       | <b>378-704</b>       |
| Magnification   | 2X                   | 0.5X                 |
| Suitable camera | 2/3" or smaller type | 1/2" or smaller type |
| Mass            | 25g                  | 25g                  |

|                             |  |
|-----------------------------|--|
| Order No.                   | <b>378-713</b>   |
| Observation method          | Bright field   |
| No. of objective mounts     | 5, with centering adjustment                                 |
| View field adjustment       | ±0.5mm   |
| Positioning accuracy        | 2σ=3μm   |
| Durability (life-time)      | 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: 130x47x186mm, 1.8kg, Console box: 108x63x176mm, 810g |

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

## Polarizer and Analyzer

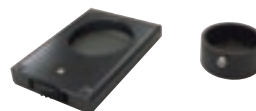
Provides simplified polarized light observation. Also enhances contrast of low-magnification objectives.

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

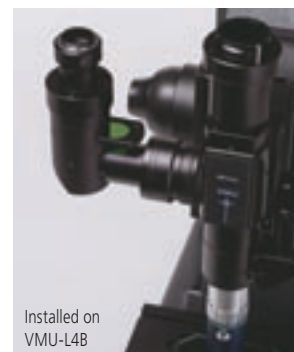
**378-715:** For VMU-LB and VUM-L4B



No.378-710



No.378-715



Installed on VMU-L4B

|           |                |                  |
|-----------|----------------|------------------|
| Order No. | <b>378-710</b> | VMU-V • VMU-H    |
| Order No. | <b>378-715</b> | VMU-LB • VMU-L4B |

## Camera mount



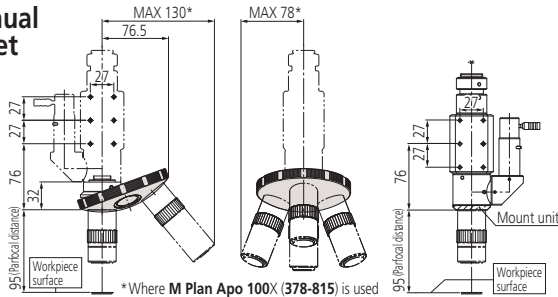
**378-087** Mass: 180g

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



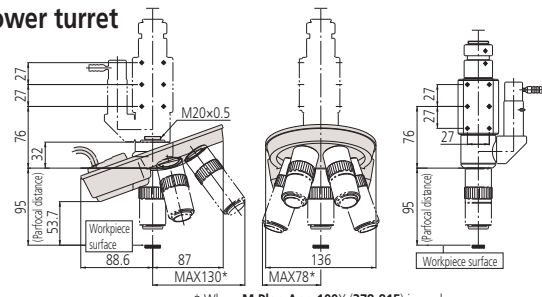
\* Where M Plan Apo 100X (378-815) is used

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

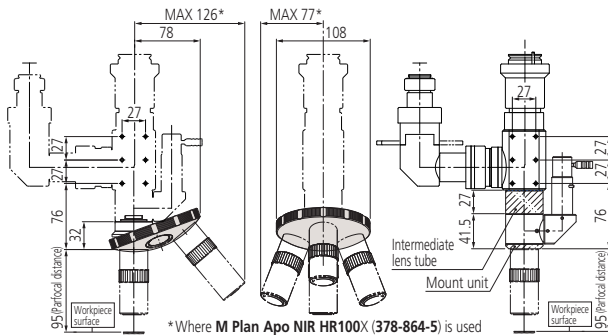


\* Where M Plan Apo 100X (378-815) is used

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)

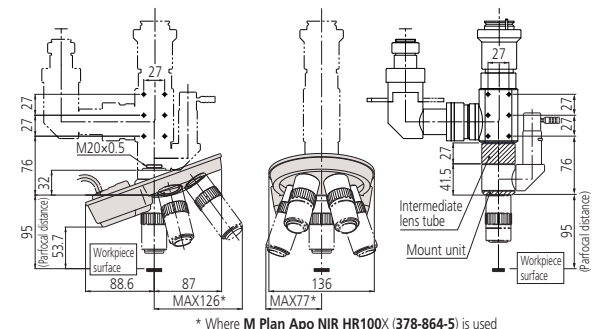


\* Where M Plan Apo NIR HR100X (378-864-5) is used

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.



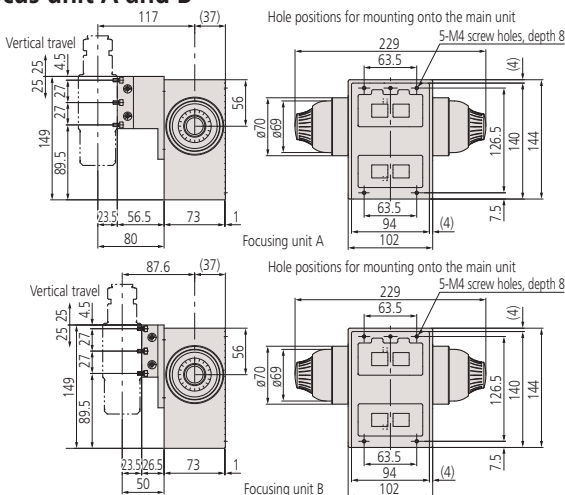
\* Where M Plan Apo NIR HR100X (378-864-5) is used

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

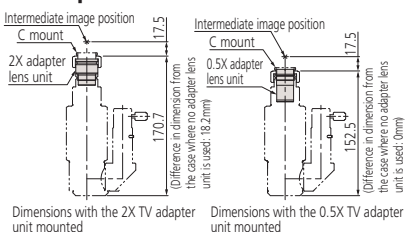
Note 1: The middle optical tube and lens mount must be removed from VMU.

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

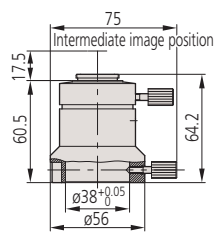
## Focus unit A and B



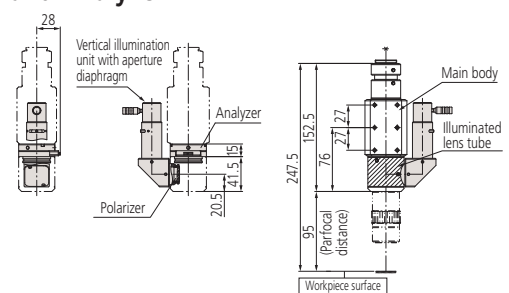
## TV adapter unit



## Camera mount

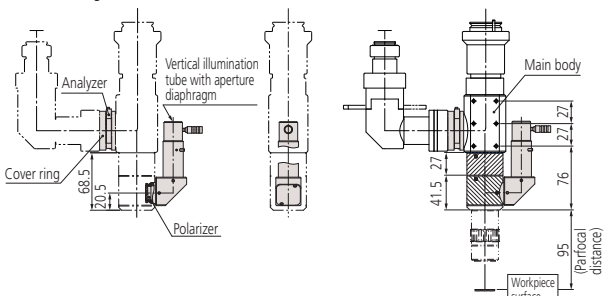


## Polarizer and Analyzer



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.

# Wide-field Video Microscope Unit

## WIDE VMU



WIDE VMU-V



WIDE VMU-H



WIDE VMU-BDV

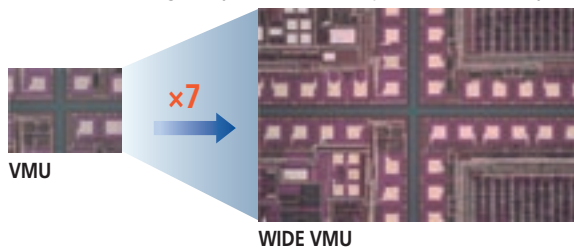


WIDE VMU-BDH

\* Objectives shown mounted on tubes are optional.

### Features

- Incorporates 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.

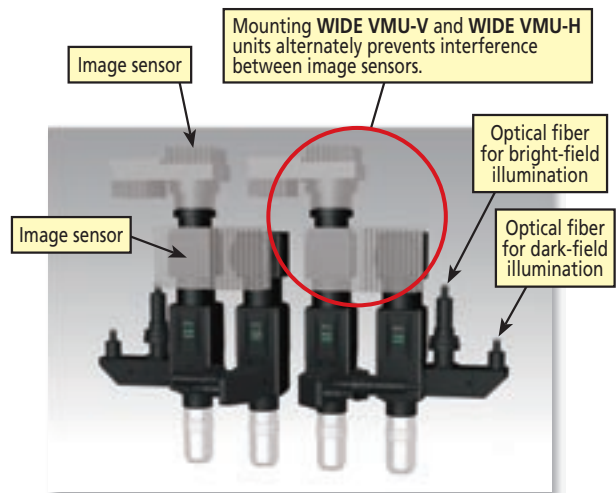


- In addition to normal bright-field observation, this series supports dark-field observation for scratch inspection, etc., and polarized light observation for increased contrast when viewing certain specimens.



WIDE VMU dark-field

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

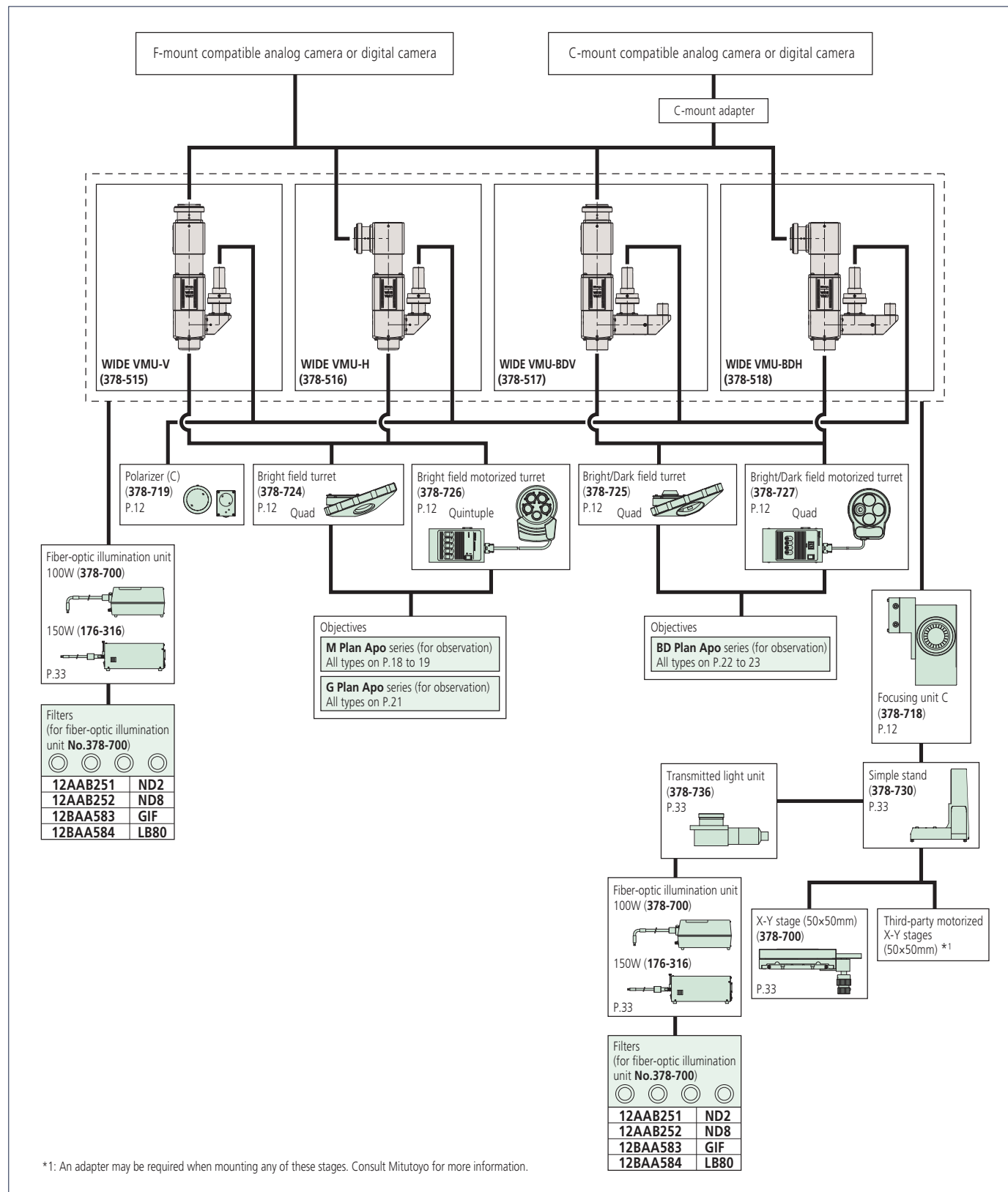


### Specifications

| Model No.                             | For Bright-field Observation  |                             | For Bright-/Dark-field Observation  |  |
|---------------------------------------|---|-----------------------------|---|--|
|                                       | 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 field and Dark field/Erect image   | Bright field and Dark field/Inverted image |
| Optical system                        | Magnification: 1X Visible light   |                             |   |  |
| Camera Mount                          | F-Mount, C-Mount (with aligning and parfocal adjustment mechanism)                                      |                             |   |  |
| Optical tube                          | Built-in 1X tube lens (Correcting wavelength range: 436 - 656nm)  |                             |   |  |
| Imaging forming (tube) lens           | ø30   |                             |   |  |
| Image field                           | Mountable   |                             |   |  |
| Polarized unit*                       | Mountable   |                             |   |  |
| Objective lens (required option)      | <b>M Plan Apo, M Plan Apo HR, M Plan Apo SL, G Plan Apo</b>   |                             | <b>BD Plan Apo, BD Plan Apo HR, BD Plan Apo SL</b>  |  |
| 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 (12V, 100W) (No. 378-700)/ (12V, 150W) (No. 176-316)                      |                             |   |  |
| Main unit mass                        | 1800g   | 1950g                       | 2000g   | 2150g                                      |

\*Polarized observation by Bright-field illumination

# System diagram



# 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.



Installed on WIDE VMU with optional objectives

| Order No.               | 378-724                                | 378-725                                    |
|-------------------------|--|--|
| Observation method      | Bright field                           | Bright/Dark field                          |
| No. of objective mounts | 4                                      | 4  |
| Mass                    | 825g                                   | 755g                                       |
| Applicable models       | <b>WIDE VMU-V</b><br><b>WIDE VMU-H</b> | <b>WIDE VMU-BDV</b><br><b>WIDE VMU-BDH</b> |

## 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. A power focus unit is also available. Refer to page 16.

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

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

## Bright field motorized turret Bright/Dark field motorized turret

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



Control box

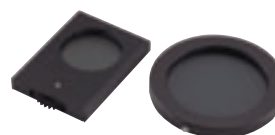
Installed on WIDE VMU with optional objectives

| 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   |
| View field adjustment   | ±0.5mm   | -   |
| Positioning accuracy    | 2σ = 3μm   | -   |
| Durability (life-time)  | 1 million repositioning operations                         | -   |
| Drive method            | DC motor   | -   |
| Power supply            | AC100V - 240V<br>Max. power consumption is approx. 10W     | AC100V - 240V<br>Max. power consumption is approx. 6W |
| Output interface        | RS-232C* for external PC control                           |   |
| Cable length            | 2.9m (connection of motorized turret and control box)      |   |
| Dimension: WxHxD (mm)   | Turret: 130x47x186mm,<br>1.8kg,                            | Turret: 164x65x137mm,<br>1.8kg,                       |
| Mass                    | Control box: 108x63x176mm,<br>810g                         | Control box: 108x72x193mm,<br>810g                    |
| Applicable models       | <b>WIDE VMU-V</b><br><b>WIDE VMU-H</b>                     | <b>WIDE VMU-BDV</b><br><b>WIDE VMU-BDH</b>            |

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

## Polarizer and Analyzer (C)

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

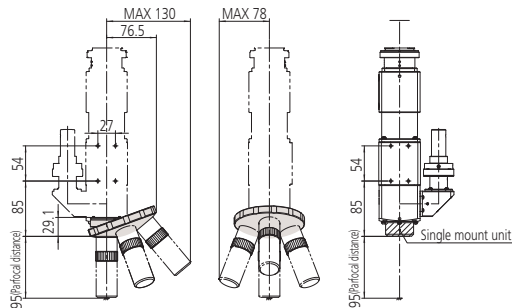


No.378-719

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

# Dimensions of Optional Accessories for WIDE VMU Series

## Bright field turret

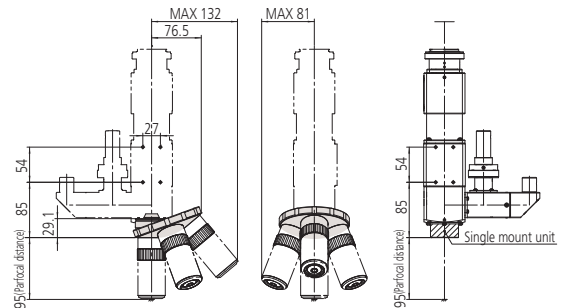


When mounting the turret on **WIDE VMU**

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

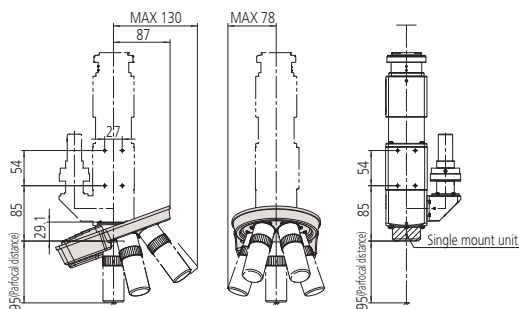


When mounting the turret on **WIDE VMU**

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 motorized turret

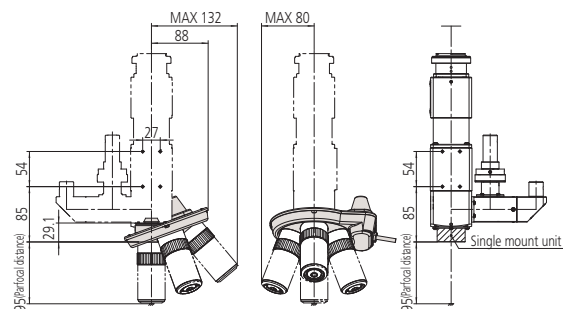


When mounting the turret on **WIDE VMU**

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 motorized turret

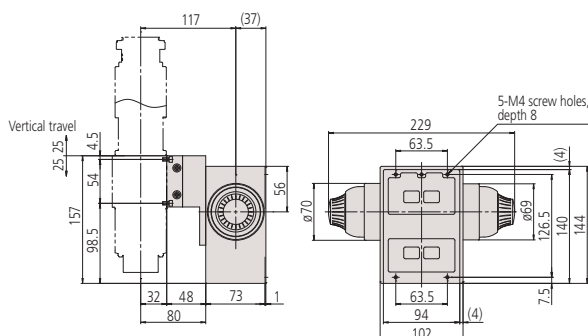


When mounting the turret on **WIDE VMU**

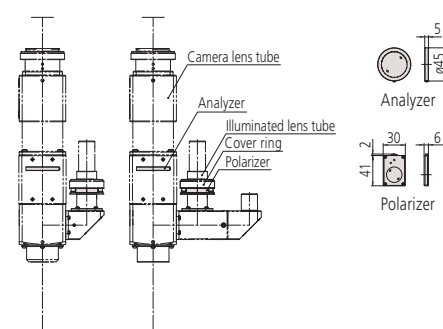
Note 1: Turret is installed by removing the single mount unit, but the distance between the mounting position of WIDE VMU main unit and the stage is unchanged.

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.

# Microscope unit FS70



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.

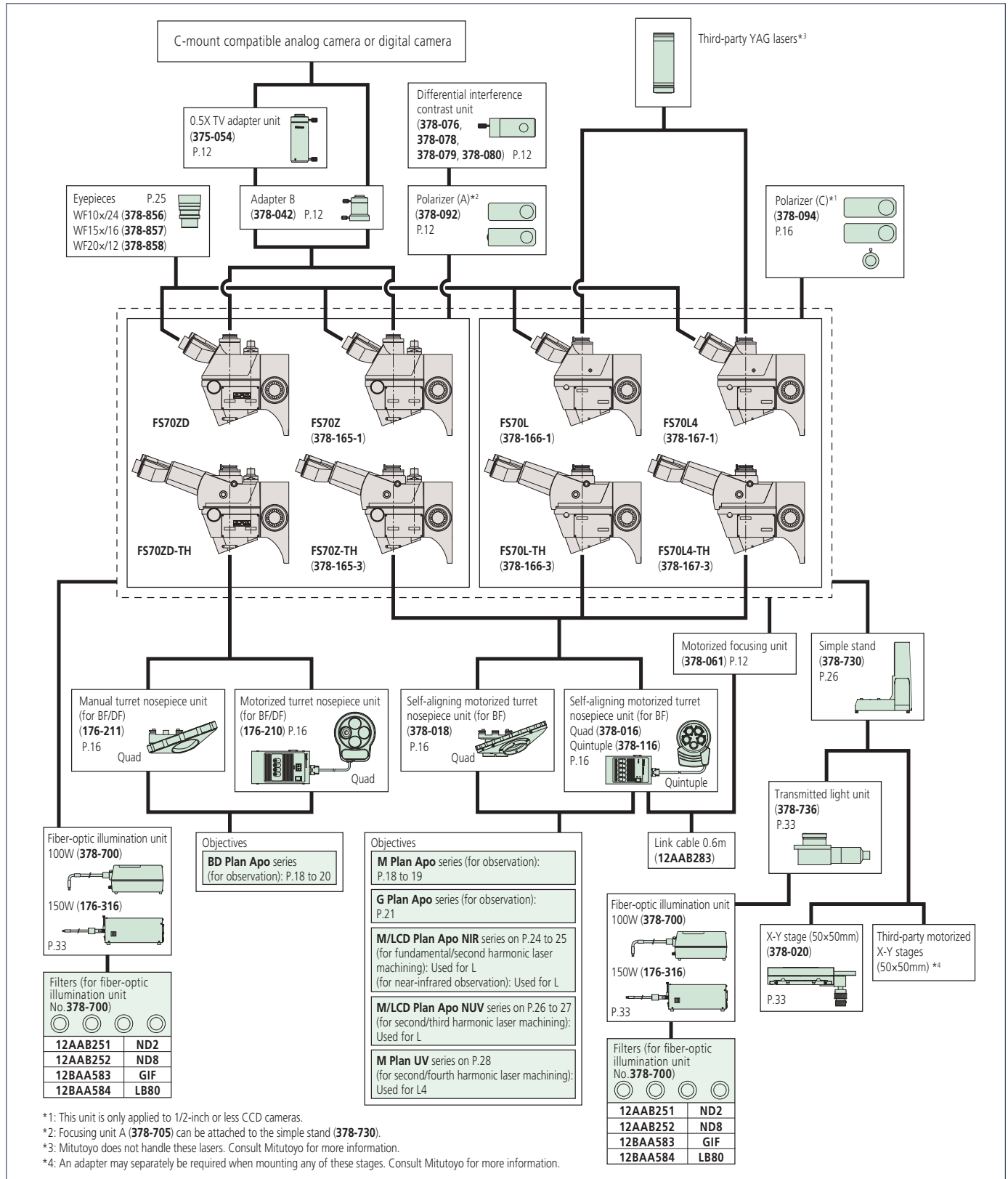
## Specifications

| 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  |  |  |                   |
|   |  | Puiple 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)                                     |                   |
|   | Laser port   | Camera mount  | C-mount with parfocal adjustment*<br>*In combination with an optional adapter B |  | C-mount with parfocal adjustment and green filter switch*<br>*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) |
| 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



# 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 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

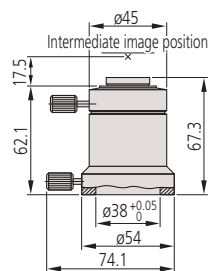
Used for differential interference contrast observation in conjunction with the polarizer.



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

## Adapter B

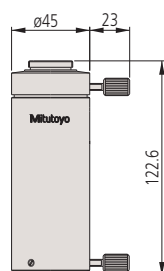
Used for mounting a C-mount camera.



378-042 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



Console box

378-016

| 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<br>(378-116: 130x47x186mm, 1.8kg)<br>Console box: 108x72x193mm, 810g<br>(378-116: 108x63x176mm, 810g) |         |                                    |

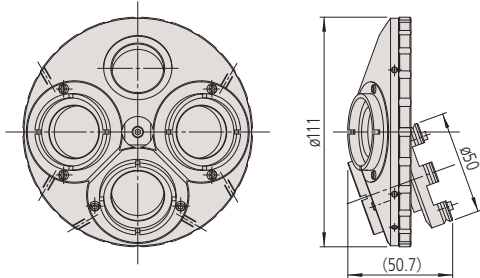
\*Optional RS-232C Cable: 12AAA807



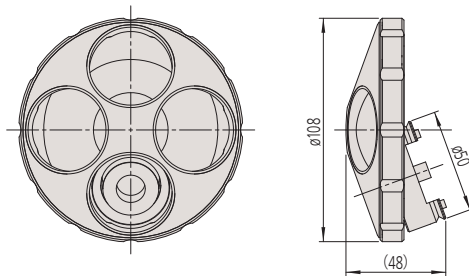
# Dimensions of Optional Accessories for FS70

## Manual turret

378-018

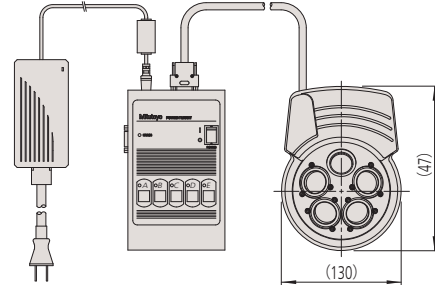


176-211

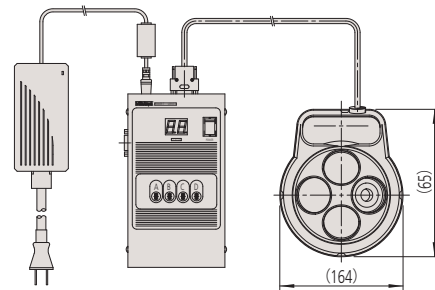


## Power turret

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).

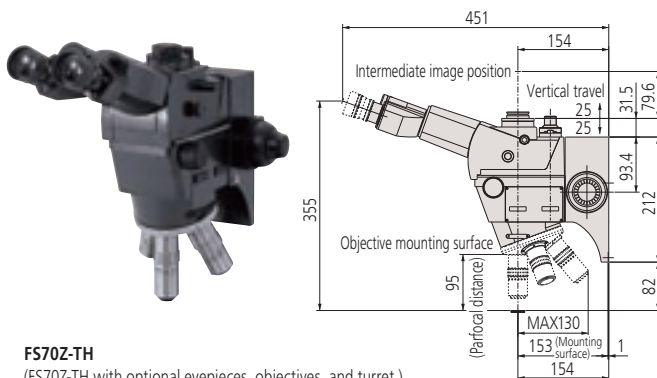
| Order No.                 | 378-026-1  |
|---------------------------|--|
| Applicable models         | Microscopes mounted with the bright/dark field manual turret or motorized turret (MF-U, HyperMF-U) |
| Applicable objective lens | M Plan Apo, M Plan Apo SL, G Plan Apo, M Plan Apo NIR, M Plan Apo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

## Focus point adjust shim set

| Order No. | Use                          | Details  |
|-----------|------------------------------|--|
| 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

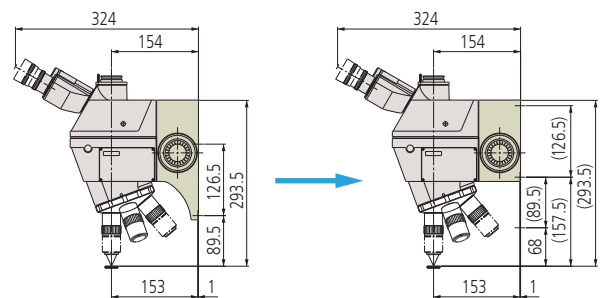
Mitutoyo's FS70-series lineup adopts a tilting head specification that allows the user to adjust the head to an appropriate eye point according to personal physical attributes when looking through the microscope eyepiece.



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

## Short focus unit type

Manual Focus Unit S can be mounted on the main unit 68mm 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 focusing unit mounting dimensions

Manual focusing unit S mounting dimensions

| Model                              | FS70Z-S  | FS70L-S        | FS70L4-S       |
|------------------------------------|--|----------------|----------------|
| Order No.                          | 378-165-2                                      | 378-166-2      | 378-167-2      |
| Travel range                       | 50mm   |                |                |
| Coarse/fine feed                   | Coarse feed: 3.8mm/rev., Fine feed: 0.1mm/rev. |                |                |
| Loading capacity of camera mount*2 | Approx. 14.0kg                                 | Approx. 13.9kg | Approx. 13.9kg |
| Mass                               | 6.6kg  | 6.7kg          | 6.7kg          |

\*Mass of turret, objective, and eyepiece are excluded.

Objectives for Bright Field Observation  
(long working distance)

M Plan Apo /  
M Plan Apo HR

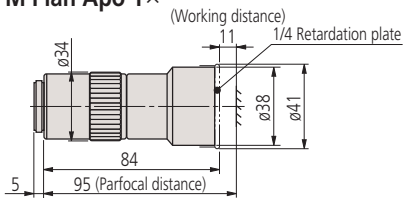
VMU WIDE VMU FS70 MF-U Hyper MF-U

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

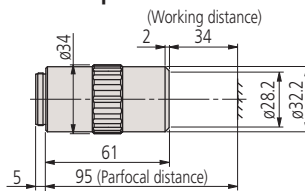


Dimensions

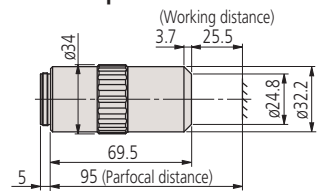
M Plan Apo 1×



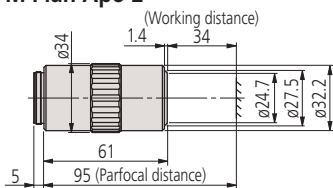
M Plan Apo 10×



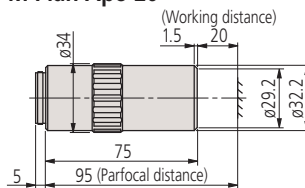
M Plan Apo HR 5×



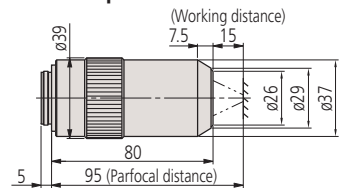
M Plan Apo 2×



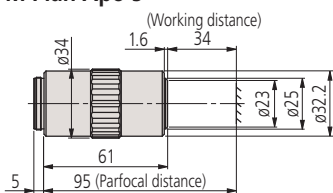
M Plan Apo 20×



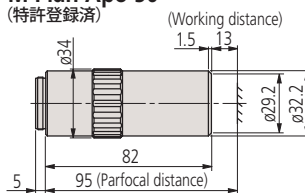
M Plan Apo HR 10×



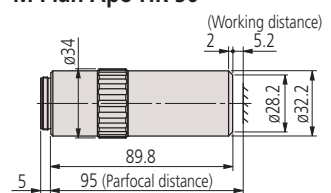
M Plan Apo 5×



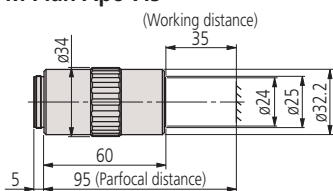
M Plan Apo 50×  
(特許登録済)



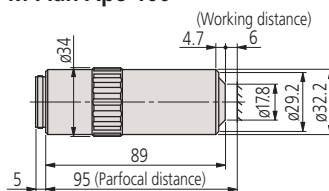
M Plan Apo HR 50×



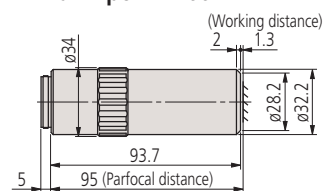
M Plan Apo 7.5×



M Plan Apo 100×



M Plan Apo HR 100×



## Specifications

| Model                | Order No.               | N.A.  | W.D. (mm) | f (mm)<br>( $\lambda=550\text{nm}$ ) | R ( $\mu\text{m}$ )<br>( $\lambda=550\text{nm}$ ) | $\pm\text{DOF}$ ( $\mu\text{m}$ ) | Real FOV (mm)      |             | Mass<br>(g) |
|----------------------|-------------------------|---|-----------|--------------------------------------|---|-----------------------------------|--------------------|-------------|-------------|
|                      |                         |   |           |                                      |   |                                   | $\phi 24$ eyepiece | 1/2" camera |             |
| <b>M Plan Apo</b>    |                         |   |           |                                      |   |                                   |                    |             |             |
| M Plan Apo 1x        | <sup>*1</sup> 378-800-3 | 0.025                                       | 11.0      | 200                                  | 11.0  | 440                               | 24                 | 4.8x6.4     | 300         |
| M Plan Apo 2x        | <sup>*2</sup> 378-801-6 | 0.055                                       | 34.0      | 100                                  | 5.0   | 91                                | 12                 | 2.4x3.2     | 220         |
| M Plan Apo 5x        | 378-802-6               | 0.14  | 34.0      | 40                                   | 2.0   | 14                                | 4.8                | 0.96x1.28   | 230         |
| M Plan Apo 7.5x      | 378-807-3               | 0.21  | 35.0      | 26.67                                | 1.3   | 6.2                               | 3.6                | 0.64x0.85   | 240         |
| M Plan Apo 10x       | 378-803-3               | 0.28  | 34.0      | 20                                   | 1.0   | 3.5                               | 2.4                | 0.48x0.64   | 240         |
| M Plan Apo 20x       | 378-804-3               | 0.42  | 20.0      | 10                                   | 0.7   | 1.6                               | 1.2                | 0.24x0.32   | 270         |
| M Plan Apo 50x       | 378-805-3               | 0.55  | 13.0      | 4                                    | 0.5   | 0.9                               | 0.48               | 0.10x0.13   | 290         |
| M Plan Apo 100x      | 378-806-3               | 0.70  | 6.0       | 2                                    | 0.4   | 0.6                               | 0.24               | 0.05x0.06   | 320         |
| <b>M Plan Apo HR</b> |                         |   |           |                                      |   |                                   |                    |             |             |
| M Plan Apo HR 5x     | <sup>*3</sup> 378-787-4 | 0.21  | 25.5      | 40                                   | 1.3   | 6.2                               | 4.8                | 0.96x1.28   | 285         |
| M Plan Apo HR 10x    | <sup>*3</sup> 378-788-4 | 0.42  | 15.0      | 20                                   | 0.7   | 1.60                              | 2.4                | 0.48x0.64   | 460         |
| M Plan Apo HR 50x    | 378-814-4               | 0.75  | 5.2       | 4                                    | 0.4   | 0.49                              | 0.48               | 0.10x0.13   | 400         |
| M Plan Apo HR 100x   | 378-815-4               | 0.90  | 1.3       | 2                                    | 0.3   | 0.34                              | 0.24               | 0.05x0.06   | 410         |
| <b>Lens set</b>      |                         |   |           |                                      |   |                                   |                    |             |             |
| Lens set B1          | 378-911                 | A set of M Plan Apo 10x, 20x, 50x, and 100x |           |                                      |   |                                   |                    |             |             |
| Lens set B2          | 378-912                 | A set of M Plan Apo 2x, 5x, 10x, and SL20x  |           |                                      |   |                                   |                    |             |             |
| Lens set B3          | 378-913                 | A set of M Plan Apo 5x, 10x, 20x, and 50x   |           |                                      |   |                                   |                    |             |             |

• Every resolution and single objective's focal depth in the above table is a value determined on the basis of a reference wavelength ( $\lambda=0.55\mu\text{m}$ ).

\*1: An appropriate polarizer should be used with this lens.

\*2: It is recommended that this lens be used with the 1/4 wavelength plate A (02ALN370) and appropriate polarizer. (Working distance will be shortened by 4mm).

\*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 (Ultra-long working distance)

## M Plan Apo SL

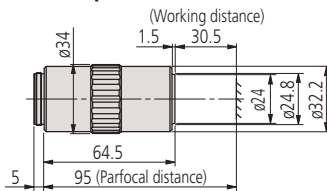
VMU WIDE VMU FS70 MF-U Hyper MF-U

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

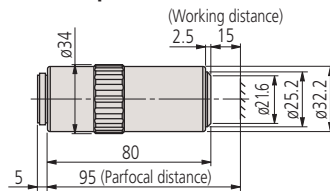


### Dimensions

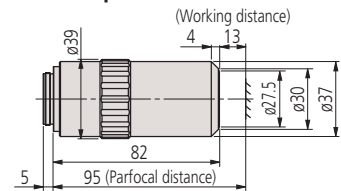
**M Plan Apo SL20×**



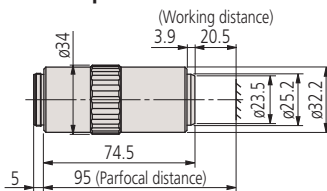
**M Plan Apo SL80×**



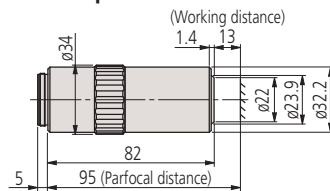
**M Plan Apo SL200×**



**M Plan Apo SL50×**



**M Plan Apo SL100×**



### Specifications

| Model                | Order No. | N.A. | W.D. (mm) | f (mm)<br>(λ=550nm) | R (μm)<br>(λ=550nm) | ±DOF (μm) | Real FOV (mm) |             | Mass (g) |
|----------------------|-----------|------|-----------|---------------------|---------------------|-----------|---------------|-------------|----------|
|                      |           |      |           |                     |                     |           | ø24 eyepiece  | 1/2" camera |          |
| <b>M Plan Apo SL</b> |           |      |           |                     |                     |           |               |             |          |
| M Plan Apo SL20×     | 378-810-3 | 0.28 | 30.5      | 10                  | 1.0                 | 3.5       | 1.2           | 0.24×0.32   | 240      |
| M Plan Apo SL50×     | 378-811-3 | 0.42 | 20.5      | 4                   | 0.7                 | 1.6       | 0.48          | 0.10×0.13   | 280      |
| M Plan Apo SL80×     | 378-812-3 | 0.50 | 15.0      | 2.5                 | 0.6                 | 1.1       | 0.3           | 0.06×0.08   | 280      |
| M Plan Apo SL100×    | 378-813-3 | 0.55 | 13.0      | 2                   | 0.5                 | 0.9       | 0.24          | 0.05×0.06   | 290      |
| M Plan Apo SL200×    | 378-816-3 | 0.62 | 13.0      | 1                   | 0.4                 | 0.7       | 0.12          | 0.025×0.03  | 490      |

• Every resolution and single objective's focal depth in the above table is a value determined on the basis of a reference wavelength (λ=0.55μm).

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

## G Plan Apo

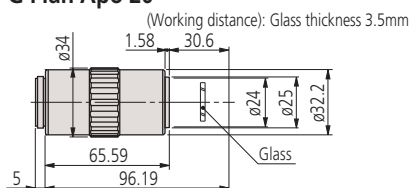
VMU WIDE VMU FS70 MF-U Hyper MF-U

- Features**
- > Infinity corrected
  - > Bright field observation
  - > Ultra-long working distance
  - > Plan-Apochromat
  - > Designed to observe a specimen through a 3.5mm cover glass.
    - > Design enables high-power observation through a cover glass.
- \* 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.

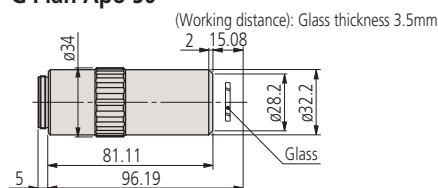


### Dimensions

**G Plan Apo 20×**



**G Plan Apo 50×**



### Specifications

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

• Every resolution and single objective's focal depth in the above table is a value determined on the basis of a reference wavelength (λ=0.55μm).

## Objectives for Bright/Dark Field Observation (long working distance)

# BD Plan Apo / BD Plan Apo HR

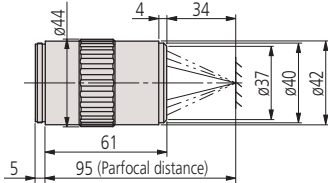
FS70 WIDE VMU MF-U Hyper MF-U

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

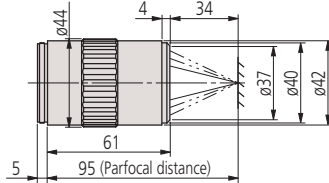


### Dimensions

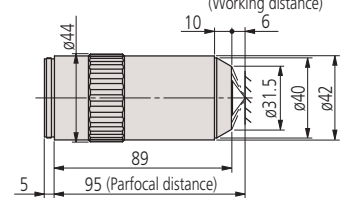
**BD Plan Apo 2×**  
(Working distance)



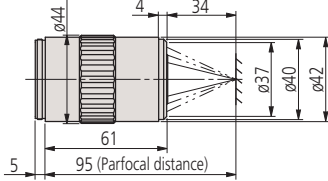
**BD Plan Apo 10×**  
(Working distance)



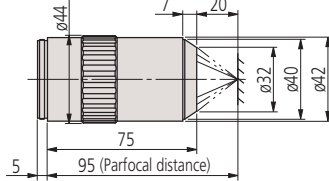
**BD Plan Apo 100×**  
(Working distance)



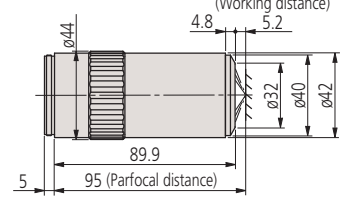
**BD Plan Apo 5×**  
(Working distance)



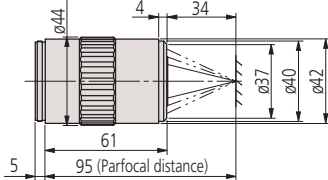
**BD Plan Apo 20×**  
(Working distance)



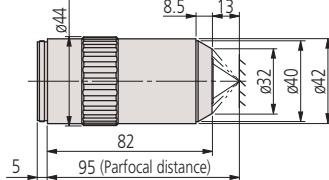
**BD Plan Apo HR 50×**  
(Working distance)



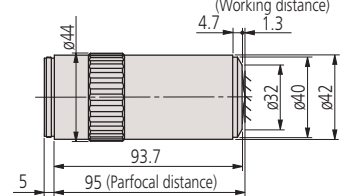
**BD Plan Apo 7.5×**  
(Working distance)



**BD Plan Apo 50×**  
(Working distance)



**BD Plan Apo HR 100×**  
(Working distance)



### Specifications

| Model                 | Order No.    | N.A.  | W.D. (mm) | f (mm)<br>(λ=550nm) | R (μm)<br>(λ=550nm) | ±DOF (μm) | Real FOV (mm) |             | Mass (g) |
|-----------------------|--------------|---|-----------|---------------------|---------------------|-----------|---------------|-------------|----------|
|                       |              |   |           |                     |                     |           | ø24 eyepiece  | 1/2" camera |          |
| <b>BD Plan Apo</b>    |              |   |           |                     |                     |           |               |             |          |
| BD Plan Apo 2×        | *1 378-831-7 | 0.055                                       | 34.0      | 100                 | 5.0                 | 91        | 12            | 2.4×3.2     | 340      |
| BD Plan Apo 5×        | 378-832-7    | 0.14  | 34.0      | 40                  | 2.0                 | 14        | 4.8           | 0.96×1.28   | 350      |
| BD Plan Apo 7.5×      | 378-830-7    | 0.21  | 34.0      | 26.67               | 1.3                 | 6.2       | 3.6           | 0.64×0.85   | 350      |
| BD Plan Apo 10×       | 378-833-7    | 0.28  | 34.0      | 20                  | 1.0                 | 3.5       | 2.4           | 0.48×0.64   | 350      |
| BD Plan Apo 20×       | 378-834-7    | 0.42  | 20.0      | 10                  | 0.7                 | 1.6       | 1.2           | 0.24×0.32   | 400      |
| BD Plan Apo 50×       | 378-835-7    | 0.55  | 13.0      | 4                   | 0.5                 | 0.9       | 0.48          | 0.10×0.13   | 440      |
| BD Plan Apo 100×      | 378-836-7    | 0.70  | 6.0       | 2                   | 0.4                 | 0.6       | 0.24          | 0.05×0.06   | 460      |
| <b>BD Plan Apo HR</b> |              |   |           |                     |                     |           |               |             |          |
| BD Plan Apo HR 50×    | 378-845-7    | 0.75  | 5.2       | 4                   | 0.4                 | 0.49      | 0.48          | 0.10×0.13   | 530      |
| BD Plan Apo HR 100×   | 378-846-7    | 0.90  | 1.3       | 2                   | 0.3                 | 0.34      | 0.24          | 0.05×0.06   | 545      |
| <b>Lens set</b>       |              |   |           |                     |                     |           |               |             |          |
| Lens set D1           | 378-931      | A set of BD Plan Apo 10x, 20x, 50x and 100x |           |                     |                     |           |               |             |          |
| Lens set D2           | 378-932      | A set of BD Plan Apo 2x, 5x, 10x, and SL20x |           |                     |                     |           |               |             |          |
| Lens set D3           | 378-933      | A set of BD Plan Apo 5x, 10x, 20x, and 50x  |           |                     |                     |           |               |             |          |

\*Every resolution and single objective's focal depth in the above table is a value determined on the basis of a reference wavelength (λ=0.55μm).

\*1: 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 4mm).

# Objectives for Bright/Dark Field Observation (Ultra-long working distance)

## BD Plan Apo SL

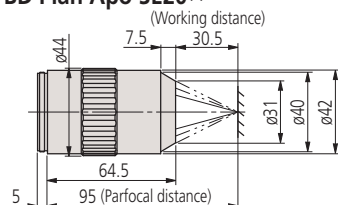
FS70 WIDE VMU MF-U Hyper MF-U

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

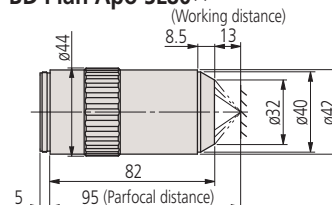


### Dimensions

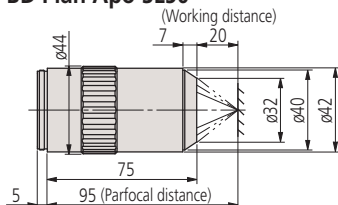
**BD Plan Apo SL20×**



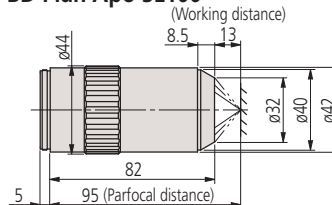
**BD Plan Apo SL80×**



**BD Plan Apo SL50×**



**BD Plan Apo SL100×**



### Specifications

| Model                 | Order No. | N.A. | W.D. (mm) | f (mm)<br>(λ=550nm) | R (μm)<br>(λ=550nm) | ±DOF (μm) | Real FOV (mm) |             | Mass (g) |
|-----------------------|-----------|------|-----------|---------------------|---------------------|-----------|---------------|-------------|----------|
|                       |           |      |           |                     |                     |           | ø24 eyepiece  | 1/2" camera |          |
| <b>BD Plan Apo SL</b> |           |      |           |                     |                     |           |               |             |          |
| BD Plan Apo SL20x     | 378-840-7 | 0.28 | 30.5      | 10                  | 1.0                 | 3.5       | 1.2           | 0.24×0.32   | 350      |
| BD Plan Apo SL50x     | 378-841-7 | 0.42 | 20.0      | 4                   | 0.7                 | 1.6       | 0.48          | 0.10×0.13   | 410      |
| BD Plan Apo SL80x     | 378-842-7 | 0.50 | 13.0      | 2.5                 | 0.6                 | 1.1       | 0.3           | 0.06×0.08   | 430      |
| BD Plan Apo SL100x    | 378-843-7 | 0.55 | 13.0      | 2                   | 0.5                 | 0.9       | 0.24          | 0.05×0.06   | 440      |

• Every resolution and single objective's focal depth in the above table is a value determined on the basis of a reference wavelength (λ=0.55μm).

## Near-infrared radiation range objectives for bright field observation

# M Plan Apo NIR / M Plan Apo NIR HR

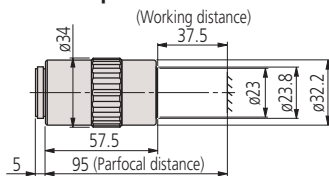
VMU FS70

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

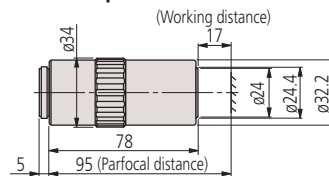


## Dimensions

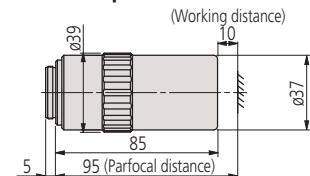
**M Plan Apo NIR 5×**



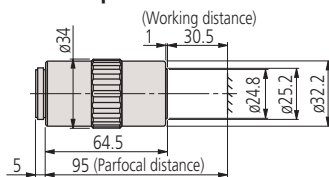
**M Plan Apo NIR 50×**



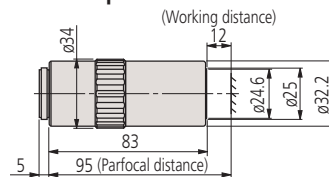
**M Plan Apo NIR HR 50×**



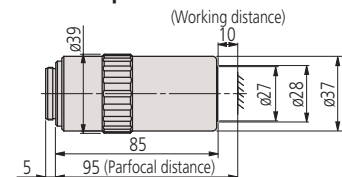
**M Plan Apo NIR 10×**



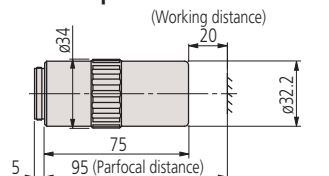
**M Plan Apo NIR 100×**



**M Plan Apo NIR HR 100×**



**M Plan Apo NIR 20×**



## Specifications

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

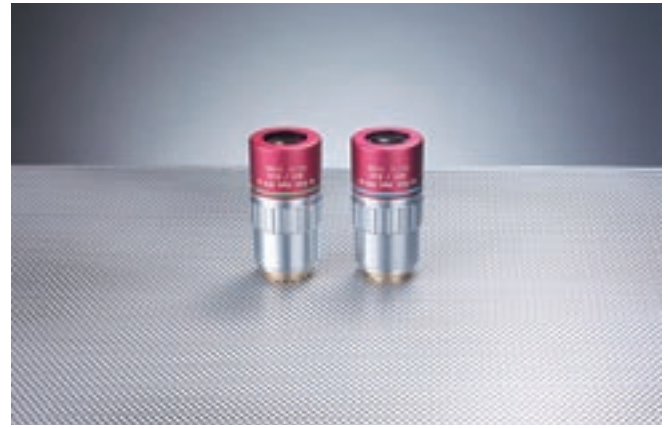
• Every resolution and single objective's focal depth in the above table is a value determined on the basis of a reference wavelength (λ=0.55μm).  
 Note: If the wavelength used is 1100nm or longer, the focal point may deviate slightly from that in visible radiation.



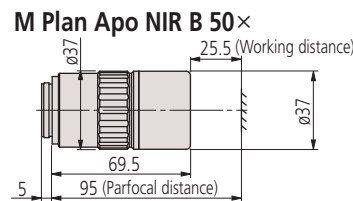
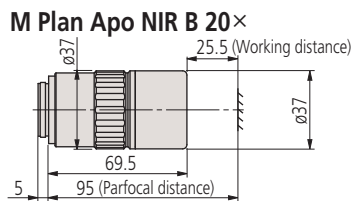
## Near-infrared radiation range objectives for bright field observation

# M Plan Apo NIR B VMU FS70

- Features**
- > Infinity corrected
  - > Suitable for bright field observation and laser applications
  - > Long working distance
  - > Plan-Apochromat
  - > A high-transmission laser type objective suited to the fundamental and second harmonic of the YAG laser. Corrected over the visible (420nm) to near-infrared (1064nm) spectrum.
  - > This series of objective has greatly improved in operability thanks to the achievement of an ultra-long working distance of 25.5mm while maintaining the NA of the NIR series 20X/50X.



### Dimensions



### Specifications

| Model                   | Order No. | N.A. | W.D. (mm) | f (mm)<br>(λ=550nm) | R (μm)<br>(λ=550nm) | ±DOF (μm) | Real FOV (mm) |             | Mass (g) |
|-------------------------|-----------|------|-----------|---------------------|---------------------|-----------|---------------|-------------|----------|
|                         |           |      |           |                     |                     |           | ø24 eyepiece  | 1/2" camera |          |
| <b>M Plan Apo NIR B</b> |           |      |           |                     |                     |           |               |             |          |
| M Plan Apo NIR B 20×    | 378-867-5 | 0.40 | 25.5      | 10                  | 0.7                 | 1.7       | 1.2           | 0.24×0.32   | 350      |
| M Plan Apo NIR B 50×    | 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 focal depth in the above table is a value determined on the basis of a reference wavelength (λ=0.55μm).  
 Note: If the wavelength used is 1100nm or longer, the focal point may deviate slightly from that in visible radiation.

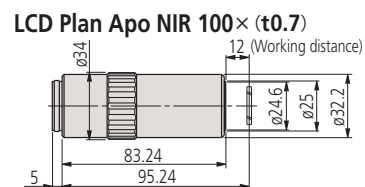
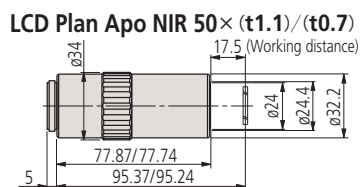
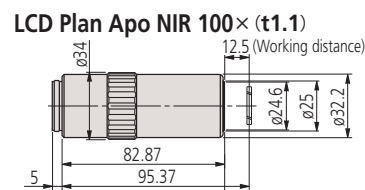
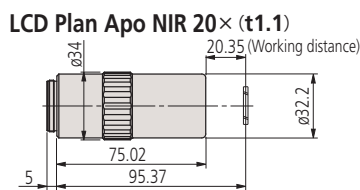
## Near-infrared radiation range objectives for bright field observation (with cover-glass thickness compensation)

# LCD Plan Apo NIR VMU FS70

- Features**
- > Infinity corrected
  - > Suitable for bright field observation and laser applications through the LCD glass
  - > Ultra-long working distance
  - > Plan-Apochromat
  - > Designed to observe a specimen through glass 1.1mm or 0.7mm thick.
  - > This makes suitable for high-power observation through a sheet of glass.
- \* Mitutoyo is ready to design and manufacture a specific sheet of glass according to a specified glass thickness and material (or refractive index).



### Dimensions



### Specifications

| Model                          | Order No. | N.A. | W.D. (mm) | f (mm)<br>(λ=550nm) | R (μm)<br>(λ=550nm) | ±DOF (μm) | Real FOV (mm) |             | Mass (g) |
|--------------------------------|-----------|------|-----------|---------------------|---------------------|-----------|---------------|-------------|----------|
|                                |           |      |           |                     |                     |           | ø24 eyepiece  | 1/2" camera |          |
| <b>LCD Plan Apo NIR</b>        |           |      |           |                     |                     |           |               |             |          |
| LCD Plan Apo NIR 20× (t1.1)    | 378-827-5 | 0.40 | 19.98     | 10                  | 0.7                 | 1.7       | 1.2           | 0.24×0.32   | 305      |
| LCD Plan Apo NIR 50× (t1.1)    | 378-828-5 | 0.42 | 17.13     | 3.9                 | 0.7                 | 1.6       | 0.48          | 0.10×0.13   | 320      |
| LCD Plan Apo NIR 50× (t0.7)    | 378-829-5 | 0.42 | 17.26     | 3.9                 | 0.7                 | 1.6       | 0.48          | 0.10×0.13   | 320      |
| LCD Plan Apo NIR 100× (t1.1) * | 378-752-5 | 0.50 | 12.13     | 2                   | 0.6                 | 1.1       | 0.24          | 0.05×0.06   | 335      |
| LCD Plan Apo NIR 100× (t0.7)   | 378-754-5 | 0.50 | 11.76     | 2                   | 0.6                 | 1.1       | 0.24          | 0.05×0.06   | 335      |

• Every resolution and single objective's focal depth in the above table is a value determined on the basis of a reference wavelength (λ=0.55μm).  
 \*Made-to-order

# Near-ultraviolet radiation range objectives for bright field observation

## M Plan Apo NUV / M Plan Apo NUV HR

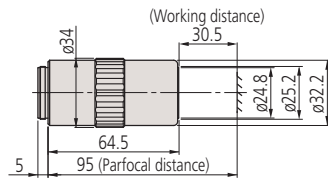
VMU FS70

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

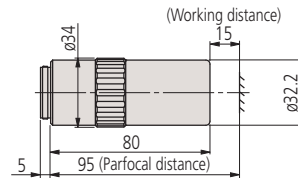


### Dimensions

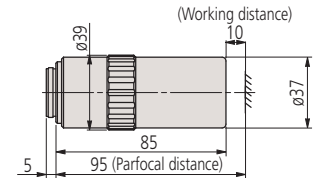
**M Plan Apo NUV 10×**



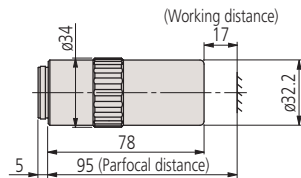
**M Plan Apo NUV 50×**



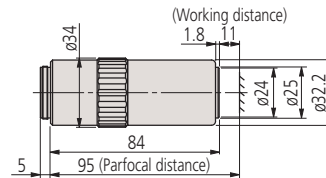
**M Plan Apo NUV HR 50×**



**M Plan Apo NUV 20×**



**M Plan Apo NUV 100×**



### Specifications

| Model                    | Order No. | N.A. | W.D. (mm) | f (mm)<br>(λ=550nm) | R (μm)<br>(λ=550nm) | ±DOF (μm) | Real FOV (mm) |             | Mass (g) |
|--------------------------|-----------|------|-----------|---------------------|---------------------|-----------|---------------|-------------|----------|
|                          |           |      |           |                     |                     |           | ø24 eyepiece  | 1/2" camera |          |
| <b>M Plan Apo NUV</b>    |           |      |           |                     |                     |           |               |             |          |
| M Plan Apo NUV 10×       | 378-809-5 | 0.28 | 30.5      | 20                  | 1                   | 3.5       | 2.4           | 0.48×0.64   | 255      |
| M Plan Apo NUV 20×       | 378-817-6 | 0.40 | 17.0      | 10                  | 0.7                 | 1.7       | 1.2           | 0.24×0.32   | 340      |
| M Plan Apo NUV 50×       | 378-818-6 | 0.42 | 15.0      | 4                   | 0.7                 | 1.6       | 0.48          | 0.10×0.13   | 350      |
| M Plan Apo NUV 100×      | 378-819-4 | 0.50 | 11.0      | 2                   | 0.6                 | 1.1       | 0.24          | 0.05×0.06   | 380      |
| <b>M Plan Apo NUV HR</b> |           |      |           |                     |                     |           |               |             |          |
| M Plan Apo NUV HR 50×    | 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 focal depth in the above table is a value determined on the basis of a reference wavelength (λ=0.55μm).

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

# LCD Plan Apo NUV / LCD Plan Apo NUV HR

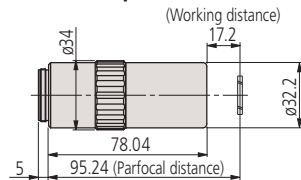
VMU FS70

- Features**
- > Infinity corrected
  - > Suitable for bright field observation and laser applications through the LCD glass
  - > Ultra-Long working distance
  - > Plan-Apochromat
  - > Designed to observe a specimen through glass 1.1mm or 0.7mm thick.
  - > This makes suitable for high-power observation through a sheet of glass.
- \* Mitutoyo is ready to design and manufacture a specific sheet of glass according to a specified glass thickness and material (or refractive index).

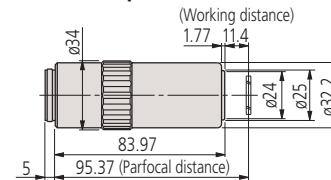


## Dimensions

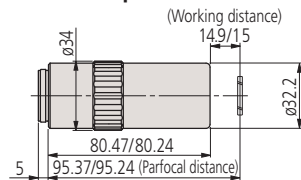
**LCD Plan Apo NUV 20× (t0.7)**



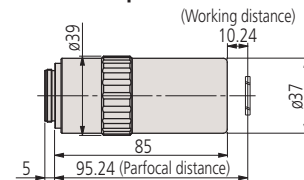
**LCD Plan Apo NUV 100× (t1.1)**



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



**LCD Plan Apo NUV HR 50× (t0.7)**



## Specifications

| Model                          | Order No. | N.A. | W.D. (mm) | f (mm)<br>(λ=550nm) | R (μm)<br>(λ=550nm) | ±DOF (μm) | Real FOV (mm) |             | Mass (g) |
|--------------------------------|-----------|------|-----------|---------------------|---------------------|-----------|---------------|-------------|----------|
|                                |           |      |           |                     |                     |           | ø24 eyepiece  | 1/2" camera |          |
| <b>LCD Plan Apo NUV</b>        |           |      |           |                     |                     |           |               |             |          |
| LCD Plan Apo NUV 20× (t0.7)    | 378-890-6 | 0.40 | 16.96     | 10                  | 0.7                 | 1.7       | 1.2           | 0.24×0.32   | 340      |
| LCD Plan Apo NUV 50× (t1.1) *  | 378-753-6 | 0.42 | 14.53     | 4                   | 0.7                 | 1.6       | 0.48          | 0.10×0.13   | 350      |
| LCD Plan Apo NUV 50× (t0.7)    | 378-820-6 | 0.42 | 14.76     | 4                   | 0.7                 | 1.6       | 0.48          | 0.10×0.13   | 350      |
| LCD Plan Apo NUV 100× (t1.1) * | 378-751-4 | 0.50 | 11.03     | 2                   | 0.6                 | 1.1       | 0.24          | 0.05×0.06   | 380      |
| <b>LCD Plan Apo NUV HR</b>     |           |      |           |                     |                     |           |               |             |          |
| LCD Plan Apo NUV HR 50× (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 focal depth in the above table is a value determined on the basis of a reference wavelength (λ=0.55μm).

\*Made-to-order

# Ultraviolet radiation range objectives for bright field observation

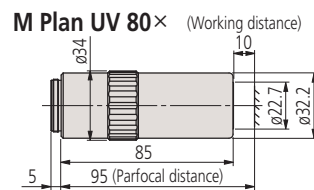
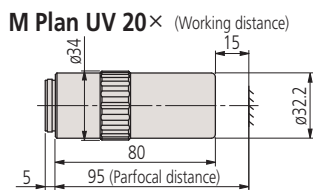
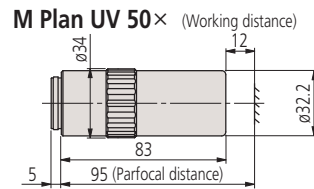
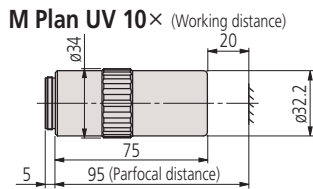
## M Plan UV

VMU FS70

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



### Dimensions



### Specifications

| Model            | Order No.  | N.A. | W.D. (mm) | f (mm)           |                  | R (μm)<br>(λ=550nm) | ±DOF (μm) | Real FOV (mm) |             | Mass (g) |
|------------------|------------|------|-----------|------------------|------------------|---------------------|-----------|---------------|-------------|----------|
|                  |            |      |           | f <sub>266</sub> | f <sub>550</sub> |                     |           | ø24 eyepiece  | 1/2" camera |          |
| <b>M Plan UV</b> |            |      |           |                  |                  |                     |           |               |             |          |
| M Plan UV 10x    | 378-844-15 | 0.25 | 20.0      | 20               | 20.3             | 1.1                 | 4.4       | 2.4           | 0.48x0.64   | 310      |
| M Plan UV 20x    | 378-837-7  | 0.36 | 15.0      | 10               | 10.4             | 0.8                 | 2.1       | 1.2           | 0.24x0.32   | 330      |
| M Plan UV 50x    | 378-838-8  | 0.41 | 12.0      | 4                | 4.5              | 0.7                 | 1.6       | 0.48          | 0.10x0.13   | 400      |
| M Plan UV 80x    | 378-839-5  | 0.55 | 10.0      | 2.5              | 2.9              | 0.5                 | 0.9       | 0.3           | 0.06x0.08   | 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=200mm, Mitutoyo tube lens). Since the focal length (f) in ultraviolet radiation (λ=266nm) is slightly smaller than that in visible radiation (λ=550nm) 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 focal depth in the above table is a value determined on the basis of a reference wavelength (λ=0.55μm).

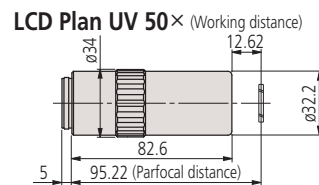
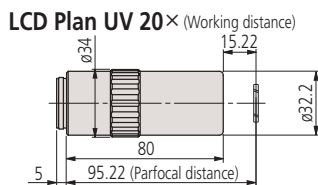
# Ultraviolet radiation range objectives for bright field observation (with cover-glass thickness compensation)

## LCD Plan UV

VMU FS70

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

### Dimensions



### Specifications

| Model                  | Order No. | N.A. | W.D. (mm) | f (mm)           |                  | R (μm)<br>(λ=550nm) | ±DOF (μm) | Real FOV (mm) |             | Mass (g) |
|------------------------|-----------|------|-----------|------------------|------------------|---------------------|-----------|---------------|-------------|----------|
|                        |           |      |           | f <sub>266</sub> | f <sub>550</sub> |                     |           | ø24 eyepiece  | 1/2" camera |          |
| <b>LCD Plan UV</b>     |           |      |           |                  |                  |                     |           |               |             |          |
| LCD Plan UV 20x (t0.7) | 378-892-7 | 0.36 | 15.0      | 10               | 10.4             | 0.8                 | 2.1       | 1.2           | 0.24x0.32   | 330      |
| LCD Plan UV 50x (t0.7) | 378-893-8 | 0.41 | 12.4      | 4                | 4.5              | 0.7                 | 1.6       | 0.48          | 0.10x0.13   | 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=200mm, Mitutoyo tube lens). Since the focal length (f) in ultraviolet radiation (λ=266nm) is slightly smaller than that in visible radiation (λ=550nm) 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 focal depth in the above table is a value determined on the basis of a reference wavelength (λ=0.55μm).

# Tube Lens MT

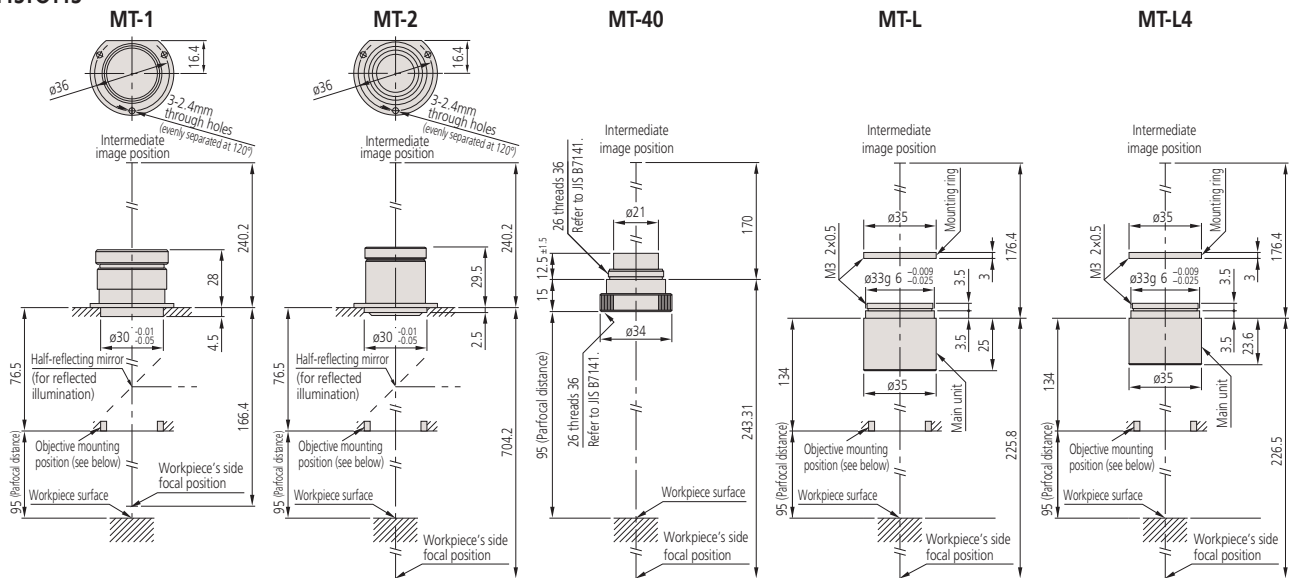
## Aberration correction range

**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) |
|----------------|-------------------|---------------------------|------------------|--------------------------|-----------------|----------|
| <b>970208</b>  | 200               | 1X                        | ø30              | ø24.0                    | ø40x32.5        | 43       |
| <b>970209</b>  | 400               | 2X                        | ø30              | ø18.0                    | ø40x32.0        | 42       |
| <b>378-010</b> | 200               | 1X                        | ø24              | ø11.2                    | ø34x27.5        | 45       |
| <b>378-008</b> | 200               | 1X                        | ø24              | ø22.0                    | ø35x32.0        | 30       |
| <b>378-009</b> | 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:

$$\ell = (\varnothing_2 - \varnothing_1) \cdot f_2 / \varnothing \quad \text{.....(1)} \quad \begin{array}{l} \varnothing_1 : \text{Objective exit pupil diameter (mm)} \\ \varnothing_2 : \text{Effective diameter of tube lens (mm)} \\ f_2 : \text{Focal length of tube lens} \\ \varnothing : \text{Image field diameter} \end{array}$$

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

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?

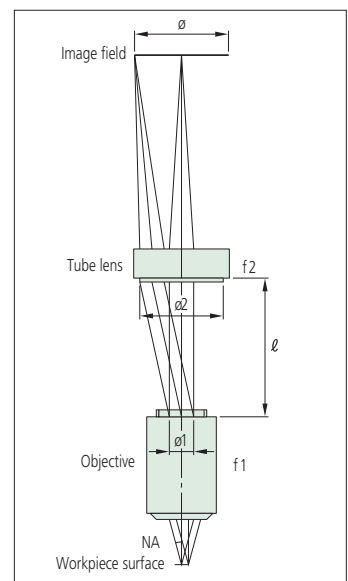
\*f=20mm, N.A.=0.28 (Refer to page 15.) \*\*ø<sub>2</sub>=24mm, f<sub>2</sub>=200mm (Refer to the above chart.)

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

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

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.



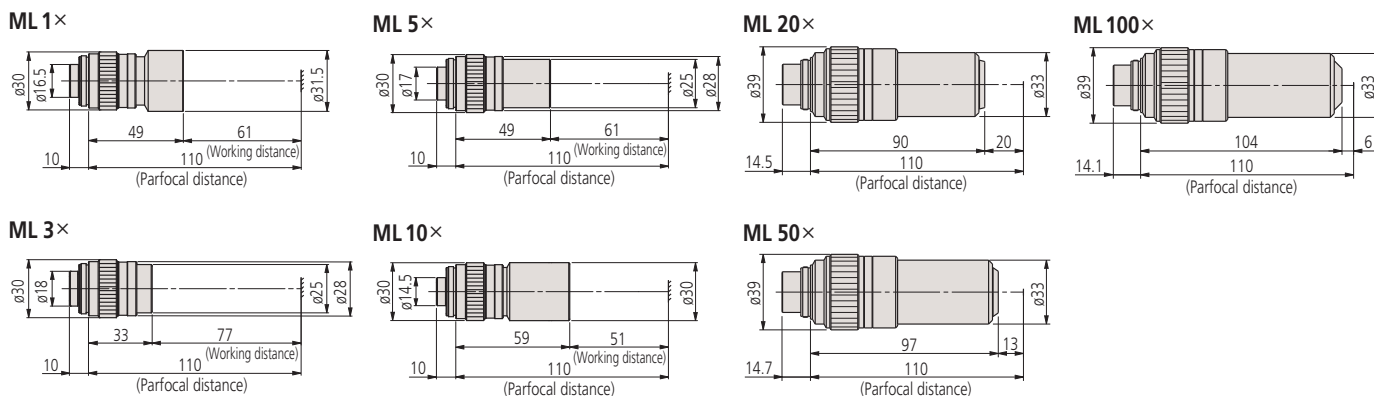
# Tube Lens ML

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



Note: The parfocal distance is a nominal value.

## Specifications

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

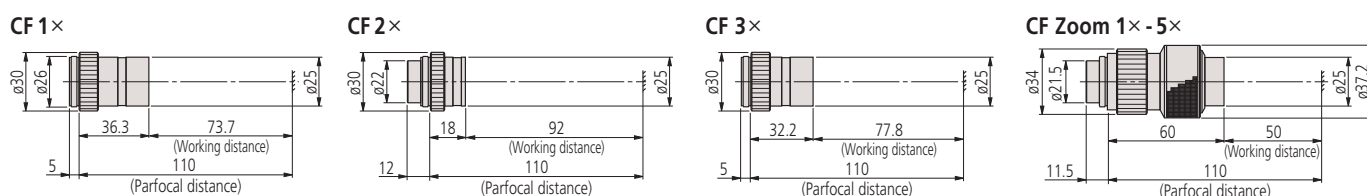
• Every resolution and single objective's focal depth in the above table is a value determined on the basis of a reference wavelength ( $\lambda = 0.55\mu\text{m}$ ).

# Tube Lens CF

CF

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

## Dimensions



Note: The parfocal distance is a nominal value.

## Specifications

| Model            | Mag. | Order No. | N.A. | W.D. (mm) | R (μm)<br>(λ=550nm) | ±DOF (μm) | Real FOV (mm) |             | Mass (g) |
|------------------|------|-----------|------|-----------|---------------------|-----------|---------------|-------------|----------|
|                  |      |           |      |           |                     |           | ø24 eyepiece  | 1/2" camera |          |
| CF 1 ×           |      | 375-031   | 0.03 | 73.7      | 9.2                 | 306       | 24            | 4.8 × 6.4   | 45       |
| CF 2 ×           |      | 375-032   | 0.06 | 92.0      | 4.6                 | 76        | 12            | 2.4 × 3.2   | 35       |
| CF 3 ×           |      | 375-033   | 0.07 | 77.8      | 3.9                 | 56        | 8             | 1.6 × 2.1   | 35       |
| CF Zzoom 1 ~ 5 × | 1 ×  | 375-038   | 0.04 | 50.0      | 6.9                 | 171       | 24            | 4.8 × 6.4   | 200      |
|                  | 3 ×  |           | 0.1  |           | 2.75                | 27        | 8             | 1.6 × 2.1   |          |
|                  | 5 ×  |           | 0.1  |           | 2.75                | 27        | 4.8           | 0.96 × 1.28 |          |

• Every resolution and single objective's focal depth in the above table is a value determined on the basis of a reference wavelength (λ=0.55μm).

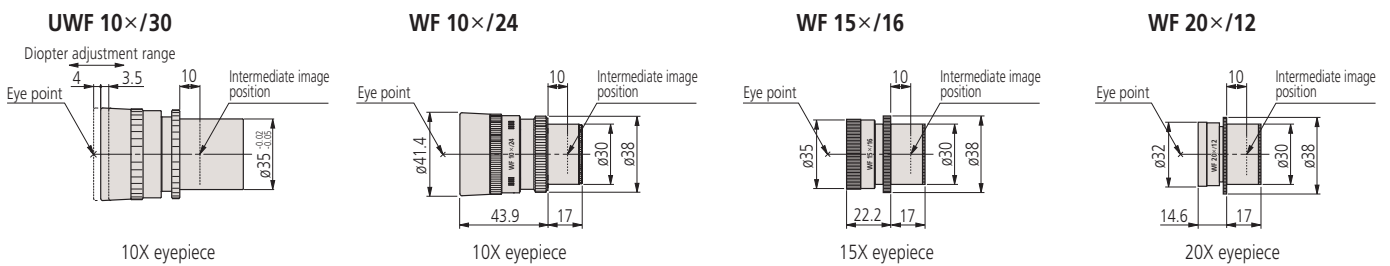
# Wide Field of View Eyepieces and Reticles WF / UWF

MF MF-U Hyper MF Hyper MF-U FS70



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

## Dimensions



## Specifications

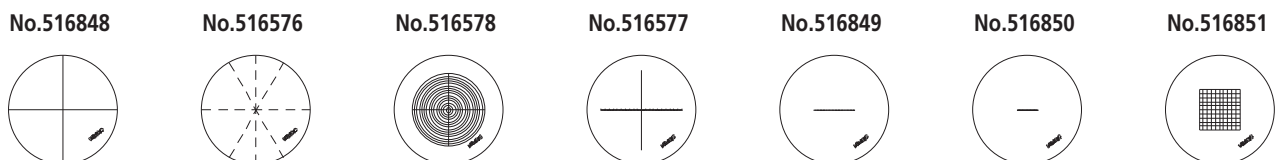
| Order No. (2pcs.) | Model                                       | Magnification | Field number | Visibility adjustment | Eye point      | Reticle   | Mass (g) |
|-------------------|---|---------------|--------------|-----------------------|----------------|-----------|----------|
| 378-851           | Ultra-wide field of view eyepiece UWF10×/30 | 10×           | 30           | -8D to +4D            | High eye point | —         | 250      |
| 378-866           | Wide field of view eyepiece WF10×/24        | 10×           | 24           | -10D to +5D           | High eye point | Available | 150      |
| 378-857           | Wide field of view eyepiece WF15×/16        | 15×           | 16           | -8D to +5D            | Normal         | Available | 40       |
| 378-858           | Wide field of view eyepiece WF20×/12        | 20×           | 12           | -8D to +5D            | Normal         | Available | 55       |

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

# Reticles

- 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. | 516848           | 516576                        | 516578   | 516577   | 516849                            | 516850                            | 516851                  |
|-----------|------------------|-------------------------------|--|--|-----------------------------------|-----------------------------------|-------------------------|
| Remarks   | Solid crosshairs | 90° and 60° broken crosshairs | Concentric circles ( $\phi 1.2$ -18mm) with solid crosshairs | Solid crosshairs with scale graduated 0.1mm/20mm | 10mm scale with 0.1mm graduations | 5mm scale with 0.05mm graduations | 1mm grid on 10mm square |



# Optional Accessories for VMU, WIDE VMU, and FS70

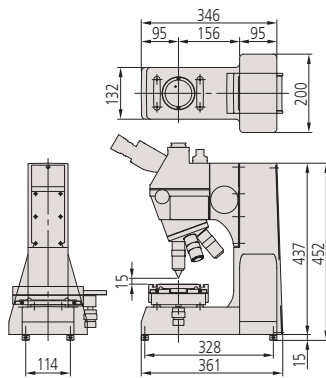
## Stand

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.

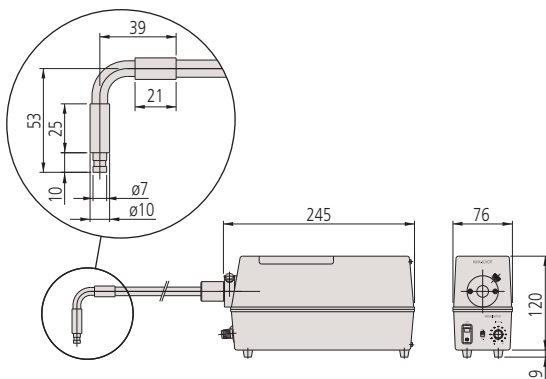


|           |                |
|-----------|----------------|
| Order No. | <b>378-730</b> |
| Mass      | 6.7kg          |

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

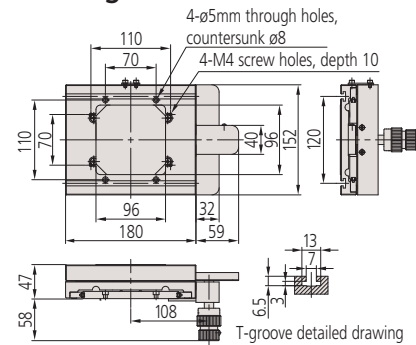


## Fiber-optic illuminator (100W)



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

## XY stage

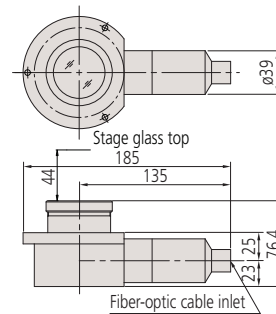


|              |                |
|--------------|----------------|
| Order No.    | <b>378-020</b> |
| Travel range | 50x50mm        |
| Handle feed  | 34mm/rev.      |
| Mass         | 3.3kg          |

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

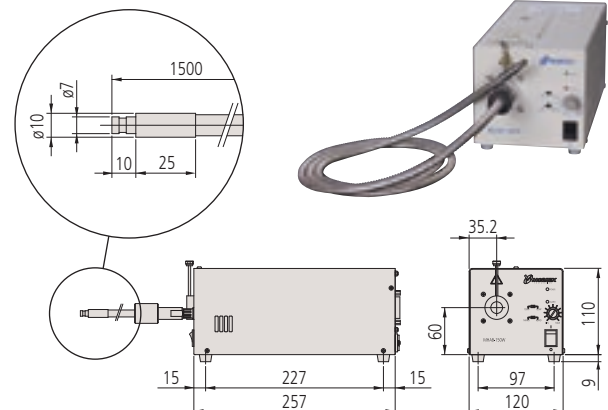
## Stage illumination unit

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



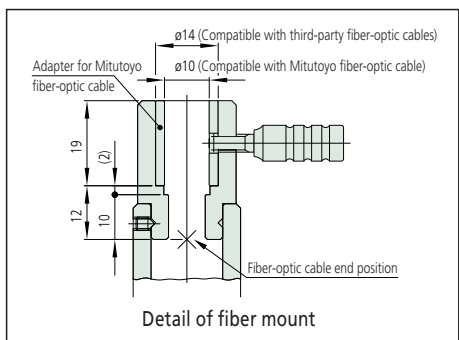
|           |                |
|-----------|----------------|
| Order No. | <b>378-736</b> |
| Mass      | 0.8kg          |

## Fiber-optic illuminator (150W)



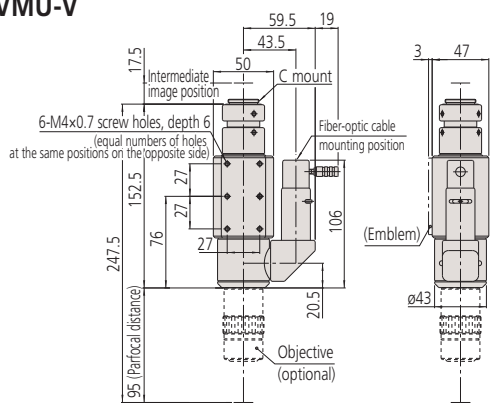
|              |   |   |
|--------------|---|---|
| Order No.    | <b>176-316D</b>                           |   |
| Light source | Long-life type                            | 15V/100W parabolic-type halogen bulb ( <b>12BAJ076</b> ), 500h service life |
|              | High-brightness type         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

# Dimensions

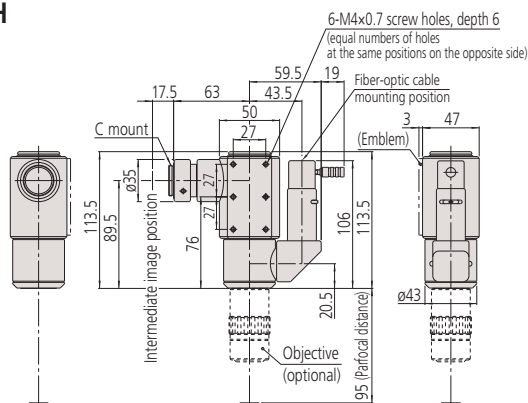


## VMU series

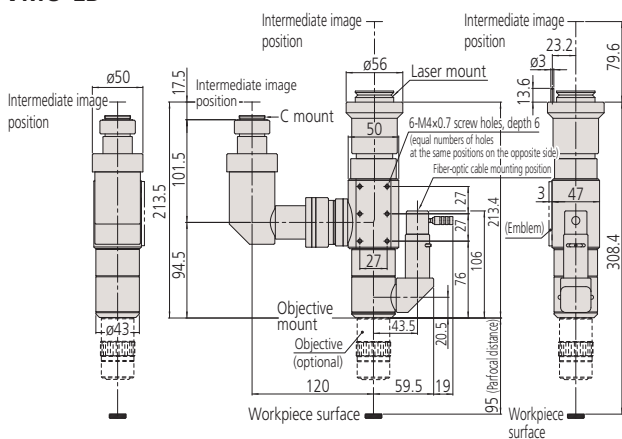
### VMU-V



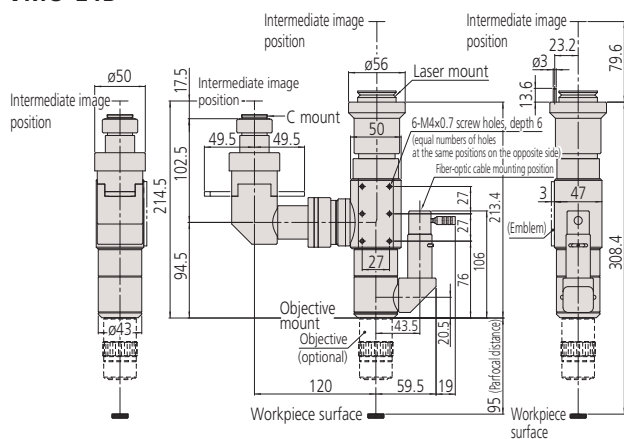
### VMU-H



### VMU-LB

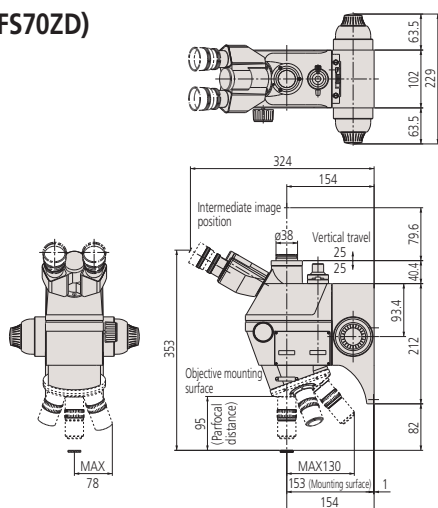


### VMU-L4B

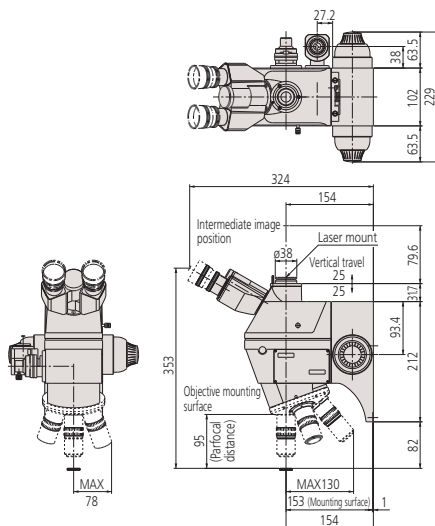


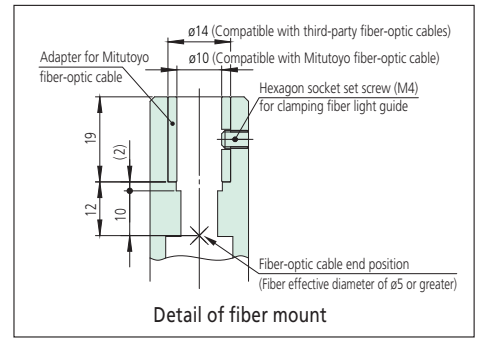
## FS70 series

### FS70Z (FS70ZD)



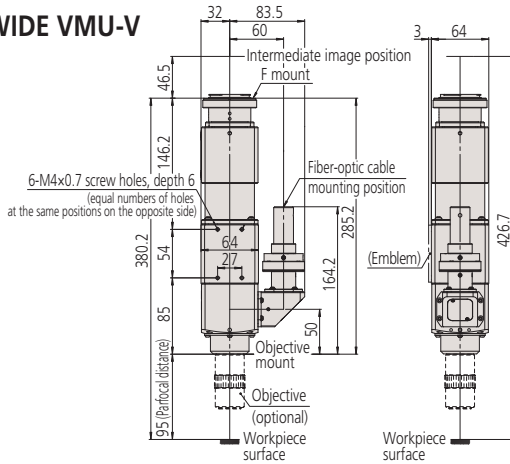
### FS70L



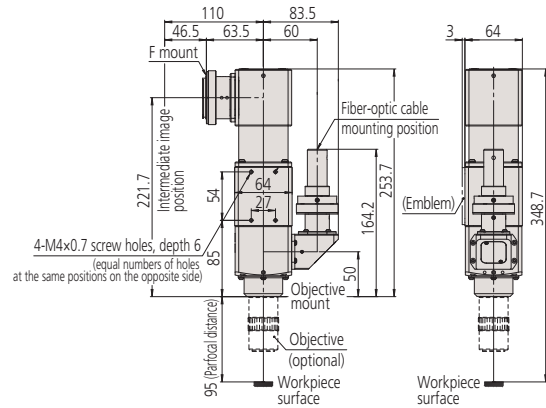


WIDE VMU series

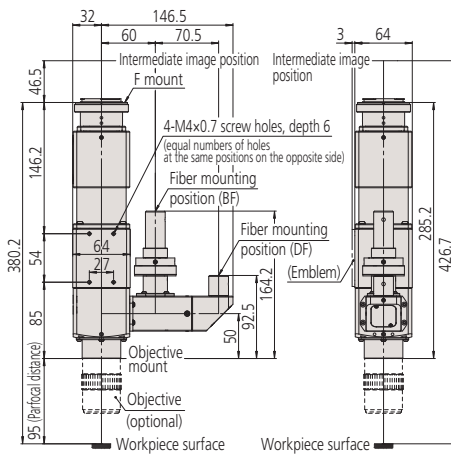
WIDE VMU-V



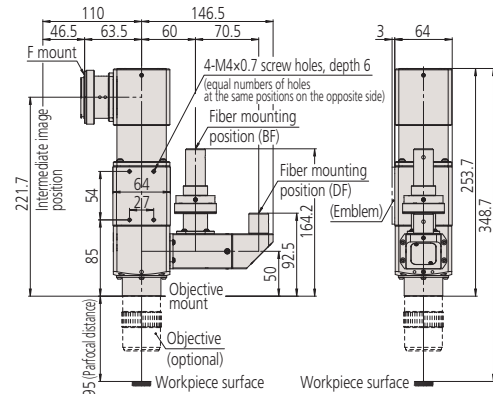
WIDE VMU-H



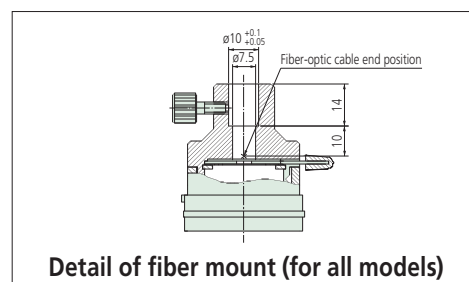
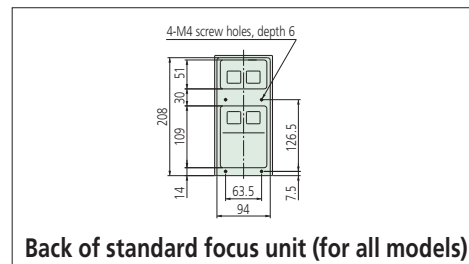
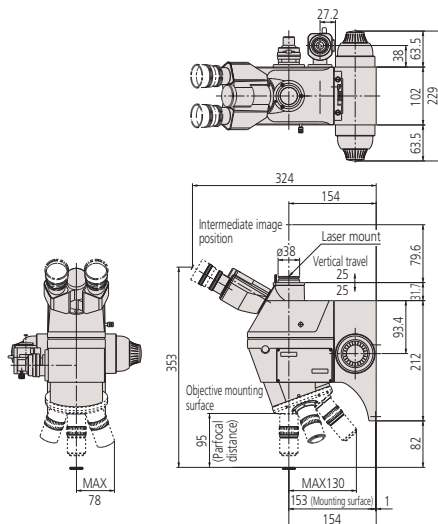
WIDE VMU-BDV



WIDE VMU-BDH

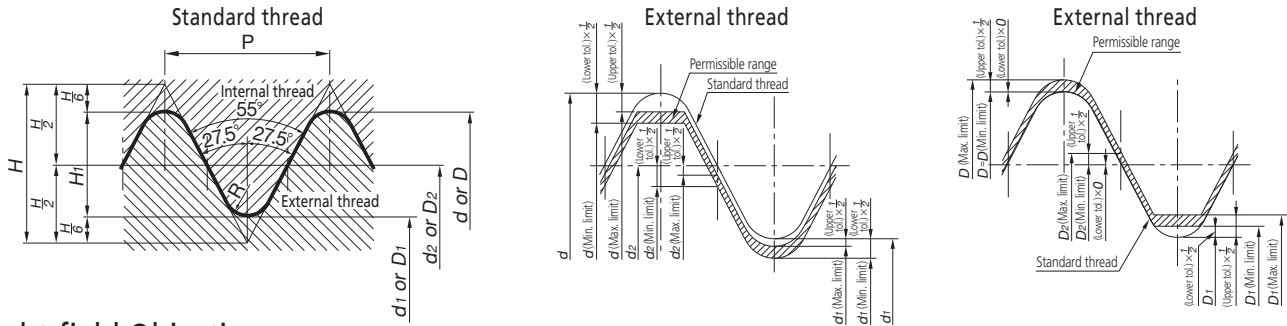


FS70L4



# 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 25.4mm) n | Pitch P | Thread peak & valley curvature radius R | External thread   |                                  |                                 |
|-------------------------|----------------------------------|---------|---|-------------------|----------------------------------|---------------------------------|
|                         |                                  |         |   | OD (d)            | Pitch diameter (d <sub>2</sub> ) | Root diameter (d <sub>1</sub> ) |
|                         |                                  |         |   | Internal thread   |                                  |                                 |
|                         |                                  |         |   | Root diameter (D) | Pitch diameter (D <sub>2</sub> ) | ID (D <sub>1</sub> )            |
| 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 <sub>2</sub> ) | Root diameter (d <sub>1</sub> ) | Root diameter (D) | Pitch diameter (D <sub>2</sub> ) | ID (D <sub>1</sub> ) |
| 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 25.4mm) n | Pitch P | Thread peak & valley curvature radius R | External thread   |                                  |                                 |
|-------------------------|----------------------------------|---------|---|-------------------|----------------------------------|---------------------------------|
|                         |                                  |         |   | OD (d)            | Pitch diameter (d <sub>2</sub> ) | Root diameter (d <sub>1</sub> ) |
|                         |                                  |         |   | Internal thread   |                                  |                                 |
|                         |                                  |         |   | Root diameter (D) | Pitch diameter (D <sub>2</sub> ) | ID (D <sub>1</sub> )            |
| 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 <sub>2</sub> ) | Root diameter (d <sub>1</sub> ) | Root diameter (D) | Pitch diameter (D <sub>2</sub> ) | ID (D <sub>1</sub> ) |
| 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

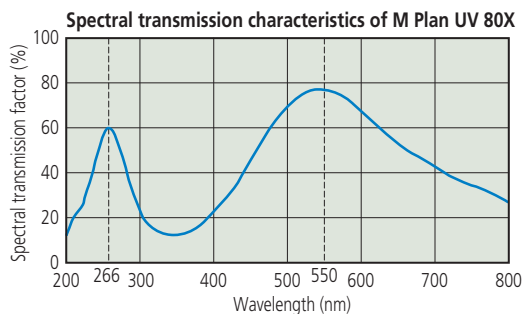
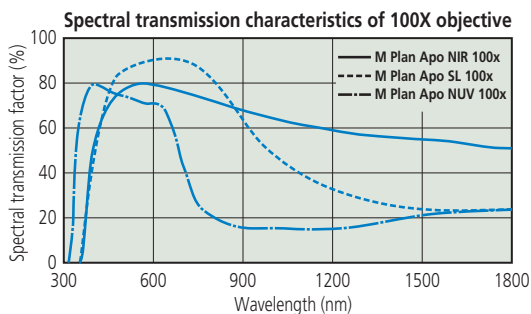
Mitutoyo's long working-distance objectives are grouped by working wavelength range: ultraviolet, near-ultraviolet, visible, and near-infrared. The M Plan UV series (for ultraviolet), M Plan Apo NUV series (for near-ultraviolet), and M Plan Apo NIR series (for near-infrared) are designed especially for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

# Commentary: Laser Operating Method and Precautions

Each VMU and FS70 series of Mitutoyo microscope units uses a built-in laser [mainly, Nd-YAG laser fundamental wave (1064nm), second harmonic (532nm), third harmonic (355nm) and fourth harmonic (266nm)] 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   |
| Pulse laser   |        |       |       |         |       |       |       |
| Upper input limit (J/cm <sup>2</sup> )              | 0.099  | 0.075 | 0.025 | 0.11    | 0.080 | 0.035 | 0.015 |
| Pulse width (10ns)                                  |        |       |       |         |       |       |       |
| Upper limit to CW laser input (kW/cm <sup>2</sup> ) | 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   |
| Pulse laser   |       |       |       |        |       |
| Upper input limit (J/cm <sup>2</sup> )              | 0.090 | 0.075 | 0.018 | 0.075  | 0.015 |
| Pulse width (10ns)                                  |       |       |       |        |       |
| Upper limit to CW laser input (kW/cm <sup>2</sup> ) | 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.

### VMU Series

| Applicable objective                                | M Plan Apo NIR series | M Plan Apo NIR series<br>M Plan Apo NUV series<br>M Plan UV series | M Plan Apo NUV series | M Plan UV series |
|---|-----------------------|--|-----------------------|------------------|
| Wavelength used (nm)                                | 1064                  | 532  | 355                   | 266              |
| Pulse laser   |                       |  |                       |                  |
| Upper input limit (J/cm <sup>2</sup> )              | 0.2                   | 0.1  | 0.05                  | 0.04             |
| Pulse width (10ns)                                  |                       |  |                       |                  |
| Upper limit to CW laser input (kW/cm <sup>2</sup> ) | 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 1064nm and a pulse width of 2.5ns, the upper limiting value of input will be 0.1J/cm<sup>2</sup>.

# Glossary

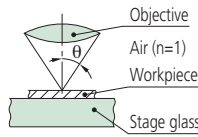
## 1. N.A. (Numerical Aperture)

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.

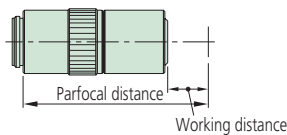
$$R (\mu\text{m}) = \frac{\lambda}{2 \cdot N.A.}$$

## 3. W.D. (Working distance)

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

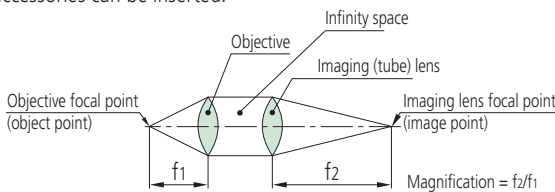
## 4. Parfocal Length

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



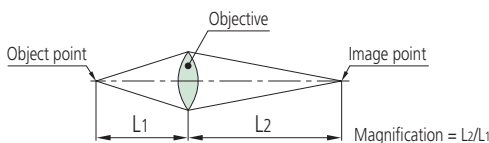
## 5. Infinity-corrected system

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<sup>1</sup> is a focal length of an objective, f<sup>2</sup> 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)

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

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

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

### TV monitor observation

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

### 10. Bright field illumination and dark field illumination

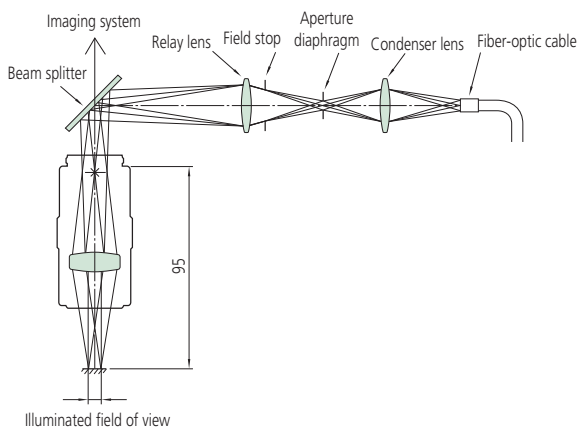
Bright field illumination directly lights the specimen with a solid cone of rays and is the simplest method available. Dark field illumination uses a hollow cone of rays formed by an opaque stop at the center of the condenser large enough to prevent direct light from entering the objective. The specimen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

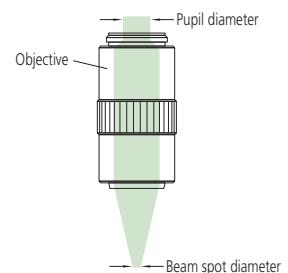
An image degrading a phenomenon in which an image appears as if it is a double image due to redundant light projection and optical interference within the optical system.

### 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.

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



#### • 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.

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

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.

$$\varnothing \mu\text{m} = \frac{4\lambda \times f}{\pi \times D}$$

Coordinate Measuring Machines



Vision Measuring Systems



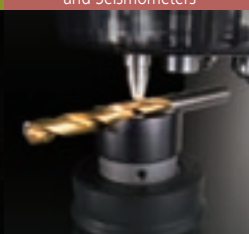
Form Measurement



Optical Measuring



Sensor Systems

Test Equipment  
and Seismometers

Digital Scale and DRO Systems

Small Tool Instruments  
and Data Management

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