

## Measuring Microscopes MF/MF-U Series



# Lineup



\*Motor-Driven Z-axis

## MF Series

Standard Measuring Microscopes

Manual MF-A/B Models

Motor-Driven Z-axis MF-J Models



\*Motor-Driven Z-axis

## MF-U Series

Universal Measuring Microscopes

Manual MF-UA/UB/UC/UD Models

Motor-Driven Z-axis MF-UJ/UK Models

# Amazing Speed-up Attainment of Reduction in Measurement Time Z-axis Motor Drive & Vision Unit

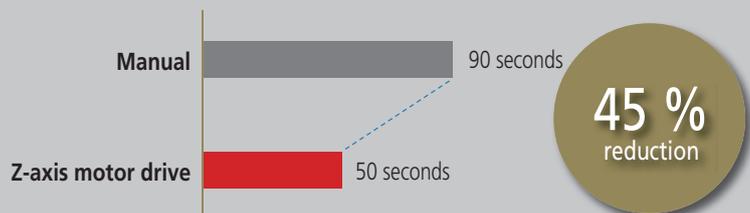
## Simple Focus Adjustment

### Ultra-high Speed AF Function

The ultra-high speed AF function has been installed to allow focusing on a surface to be measured at a speed of about one second.

Freedom from burdensome focus adjustment even on a workpiece with many asperities allows the operator to perform stress-free measurement, drastically reducing operator's fatigue.

#### Application example: Cumulative total time of 3 mm step-height measurement 10 times



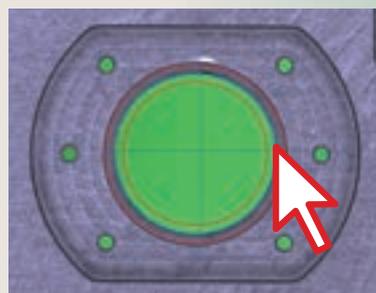
\* The amount of time saved is dependent on the particular workpiece and therefore this result is offered as an example but does not guarantee performance in all cases.

## Simplified Measurement

### One-click Tool

The concurrent use of the vision unit as a vision measurement system allows simplified measurement of an edge by merely one click. Moreover, since many data points can be obtained at a time with just one click, this will drastically speed up measurement and reduce data spread compared with the conventional method of "measuring data points one by one with cross hairs".

\* Vision unit: Option



One-click circle tool



One-click box tool



See video from here

Feature

# Excellent Observability and Operability

## Ultra-wide View Field and High Magnification Observation

### Field Number: 24

This measuring microscope series has achieved an industry-leading wide field of view of  $\varnothing 24$  mm (when using 1X objective).

### A Camera Port on All Models

All models are equipped with a C-mount port as standard to which a compatible camera is attachable. The port allows a vision measurement system or an observation-specific digital camera to be mounted.

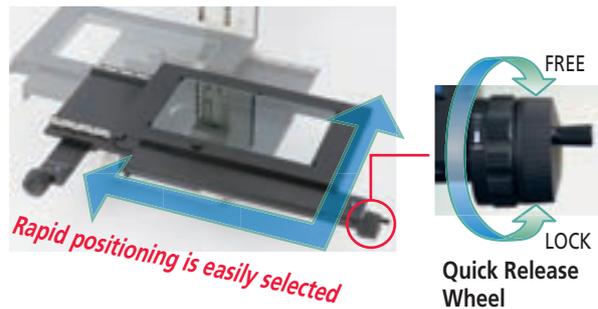
### Lineup of a Wide Range of Objectives

The objectives available provide a choice of ultra-low magnification, for excellent flare suppression, to high magnification that approaches the resolution limit possible with optical wavelengths, allowing the customer to select an optimal magnification depending on the intended use.

## Intuitive Operation

### Quick Release Mechanism

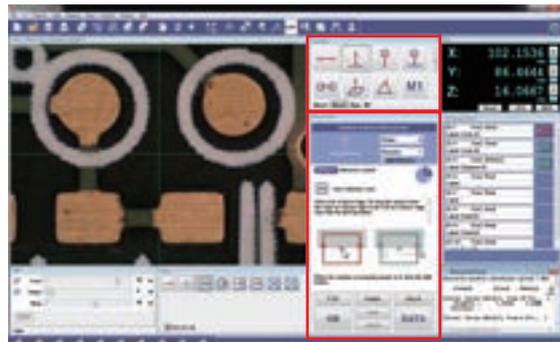
The manual stage provides intuitive positioning and can be easily moved rapidly between measuring positions on a workpiece by using the quick release function on each axis. Just free a Quick Release Wheel and move the stage by pushing and pulling. Lock the wheel to continue measurement with fine feed. Very effective for traversing between widely separated positions.



### Vision Unit

The vision unit allows anyone to perform simplified measurement of an edge with just one click. Also, using the vision unit eliminates the need for burdensome parallel alignment of a workpiece and data point detection with cross hairs, thus allowing quick inspection of dimensions.

Vision unit: Option (Refer to page 10 to 14 for details)



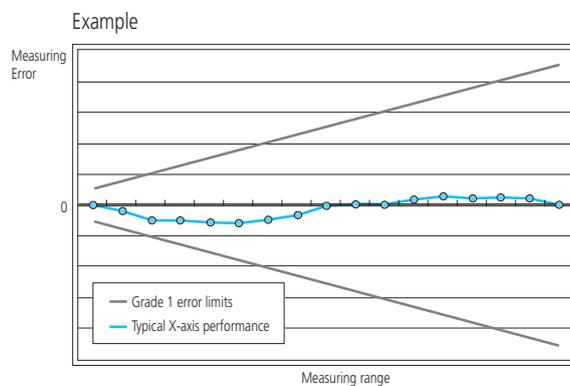


# High-accuracy Measurement

Best-in-Class Accuracy As of April, 2016

## X/Y Axis: $(2.2+0.02L) \mu\text{m}$

All models have achieved best-in-class accuracy performance. Since the accuracy of the whole system is ensured by conformity to the inspection method of JIS B 7153, any model enables high-accuracy measurement. Any measuring microscope that achieves this accuracy performance (close to JIS Class 0) will be a great asset to the customer's quality control improvement program.



Reference) Measuring accuracy of each axis of a JIS B 7153 measuring microscope (at 20 °C)  
 Grade 0:  $(2+0.01L) \mu\text{m}$  or less  
 Grade 1:  $(4+0.02L) \mu\text{m}$  or less L: measured length (mm)

## A Wide Choice of Stage Size

Precisely because measuring microscopes in this series are widely used in widely different industries, Mitutoyo offers a choice of stage size from 100×100 mm to maximum-in-class 400×200 mm. The customer can choose the optimal size for the application with accuracy performance guaranteed.



Feature

## MF Series – User-friendly Standard Model –

### Reduction in Magnification Error due to Variation in Point of Focus

#### Telecentric Optical System

In order not to change the observing magnification even at low magnification (10X or less) where the objective's precise working distance is difficult to accurately reproduce because of a wide focal depth, this series has adopted the telecentric optical system that reduces the magnification error due to slight variation in working distance.

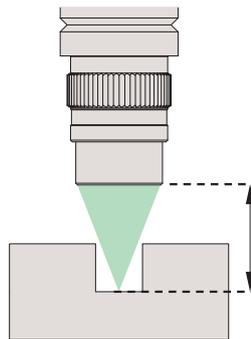
Also, the MF series objectives are manufactured with a more accurate magnification due to Mitutoyo's unique specification that surpasses JIS Standards. This optimizes comparative measurement with a reticle.



### Safe Operation

#### Ultra-long Working Distance

An ultra-long working distance is ensured in the entire lineup of a wide variety of objectives between 1X and 100X. This practically eliminates any risk of collision with a workpiece even when surface asperities are present.



Working distance	Objective
61.0 mm	ML1X
77.0 mm	ML3X
61.0 mm	ML5X
51.0 mm	ML10X
20.0 mm	ML20X
13.0 mm	ML50X
6.0 mm	ML100X

### Easy Change of Magnification

#### Sliding Nosepiece

The MF series usually allows only a single objective to be mounted which needs to be replaced for every magnification change. The sliding nosepiece allows up to two objectives to be mounted.

In the case of measurement that needs frequent magnification change, this nosepiece design drastically improves workability. (Refer to page 18 for details)





## Manual (2- or 3-axis)



## Z-axis Motor Drive



View of icons	
	Standard-equipped function
	Not supported

**Camera Port** Camera port for mounting a digital camera (standard equipment on all models)

**Zero-setting** Handy zero-set switch that minimizes the operator's hand motion

**FS Objective** Possible to mount an objective that enables various observation methods. (Only for the MF-U series)

**Z-axis Motor** Z-axis motor drive for fast Z-axis focusing

**Remote** Remote control box that enables handy operation

**Counter** Low-profile digital display possible to install on the left or right side and adjust tilt angle to suit the operator

**Quick Release** Quick-release mechanism that allows rapid stage positioning (Only for manual XY stage models)

**Tilting** Tilting optical tube that can adjust the eyepoint to suit the operator's physique (Standard-equipped in the MF-U series)

**Vision AF** Vision auto focus function that speeds up measurement by reducing the operator's focusing error

**Power Turret** Motor-powered turret enables faster operation when several objectives are required for measurement

Feature

MF-U Series – Universal Model Dealing with Diverse Observation Methods –

Clear Observation Image

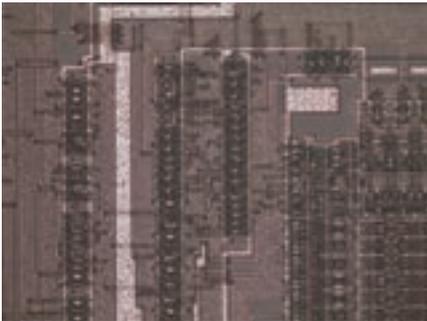
Apochromat Lenses

This series provides a clear observation image with excellent color quality, ultra-long working distance for high operability and apochromatic design that eliminates chromatic aberration.

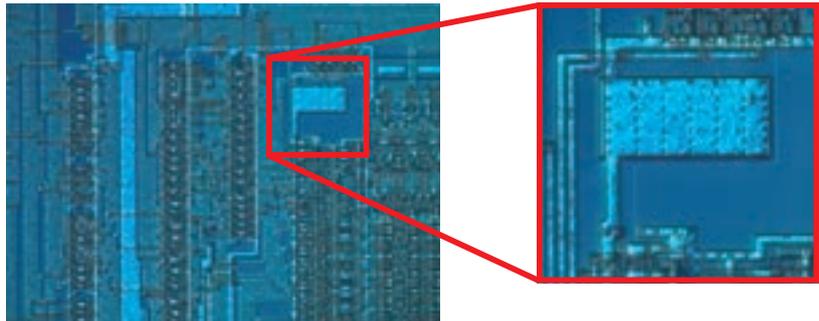
Detection of Microscopic Flaws and Asperities

Diverse Observation Methods

A choice of observation method such as dark-field observation, simple polarized observation and differential interference observation in addition to bright-field observation of magnified images are selectable depending on the intended use.



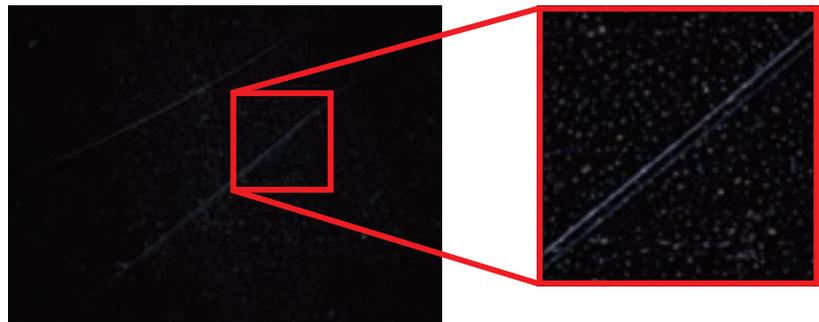
Ordinary observation (bright-field)



Differential interference: Allows observation of microscopic asperities hard to detect with ordinary bright-field observation.



Ordinary observation (bright-field)



Dark-field: Allows highlighted observation of microscopic abnormalities such as flaws and contamination by using diffused light.

Polarization Unit

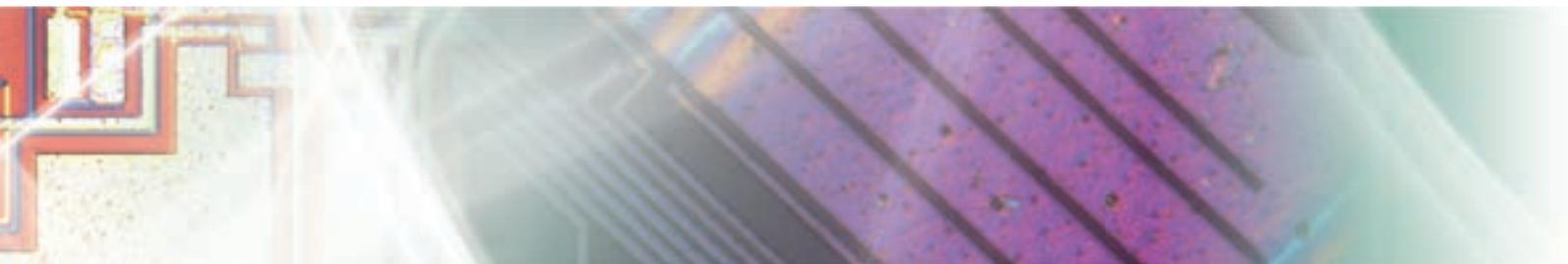
Used when performing simple polarized observation. It is also recommended to use this unit for increasing image contrast during use of a low-magnification lens.



Differential Interference Unit

Used when performing differential interference observation. This unit is used in combination with the polarization unit.





### Manual (2- or 3-axis)



- Camera Port
- Counter
- Zero-setting
- Quick Release
- FS Objective
- Tilting
- Z-axis Motor
- Vision AF
- Remote
- Power Turret

### Z-axis Motor Drive



- Camera Port
- Counter
- Zero-setting
- Quick Release
- FS Objective
- Tilting
- Z-axis Motor
- Vision AF
- Remote
- Power Turret

View of icons	
	Standard-equipped function
	Not supported
	Selectable as an option

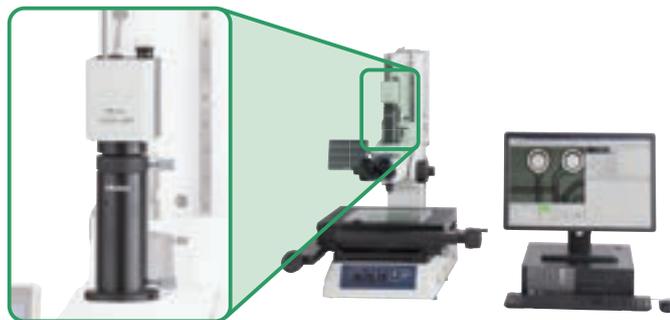
- Camera Port** Camera port for mounting a digital camera (standard equipment on all models)
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- Z-axis Motor** Z-axis motor drive for fast Z-axis focusing
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- Counter** Low-profile digital display possible to install on the left or right side and adjust tilt angle to suit the operator
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- Power Turret** Motor-powered turret enables faster operation when several objectives are required for measurement

# Optional Accessories

Camera/Images

## Vision Unit

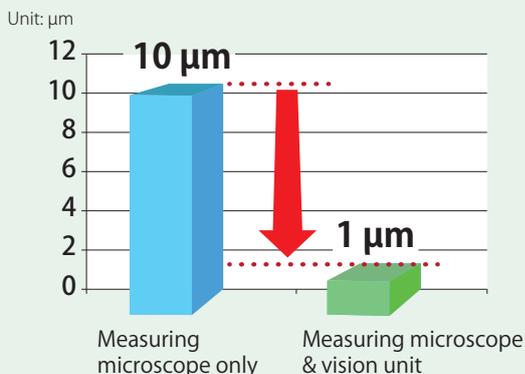


System example

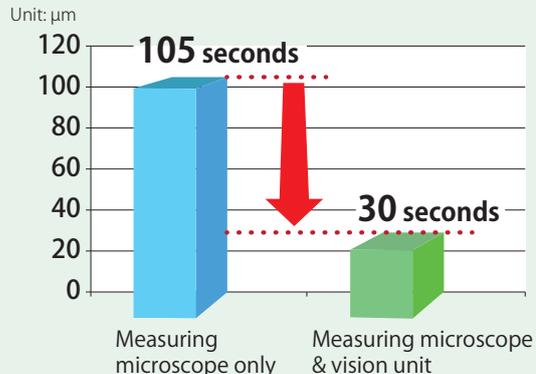
### Reduction of Variation/Improvement in Efficiency

The vision unit allows anyone to perform simplified measurement of an edge with just one click. Also, using the vision unit eliminates the need for burdensome workpiece orientating and data point detection with cross hairs, thus allowing quick inspection of dimensions.

About **90%** reduction in variation



About **70%** reduction in average measurement time



Measurement results and measurement times when measuring a width of about 20 mm thrice (continuous reciprocation)  
Measurement with the measuring microscope only

	Operator A	Operator B	Operator C		
Max. value (mm)	20.0863	20.0849	20.0811	Max. value (mm)	20.0863
Min. value (mm)	20.0765	20.0802	20.0758	Min. value (mm)	20.0758
Variation (mm)	0.0098	0.0047	0.0053	Variation (mm)	<b>0.0105</b>
Measurement time (sec)	76	150	89	Measurement time (sec)	<b>105</b>



Measurement with the measuring microscope & vision unit

	Operator A	Operator B	Operator C		
Max. value (mm)	20.0847	20.0853	20.085	Max. value (mm)	20.0853
Min. value (mm)	20.0846	20.0842	20.0837	Min. value (mm)	20.0837
Variation (mm)	0.0001	0.0011	0.0013	Variation (mm)	<b>0.0016</b>
Measurement time (sec)	36	23	25	Measurement time (sec)	<b>28</b>

### Simplified Report/Storage Function

This series has the functions to perform tolerance verification of measurement/calculation results, various statistical processing for each item and image load/storage, enabling storage of measurement results and images at measured points. Since measurement results can also be outputted in the CSV format, this allows smooth creation of inspection table.

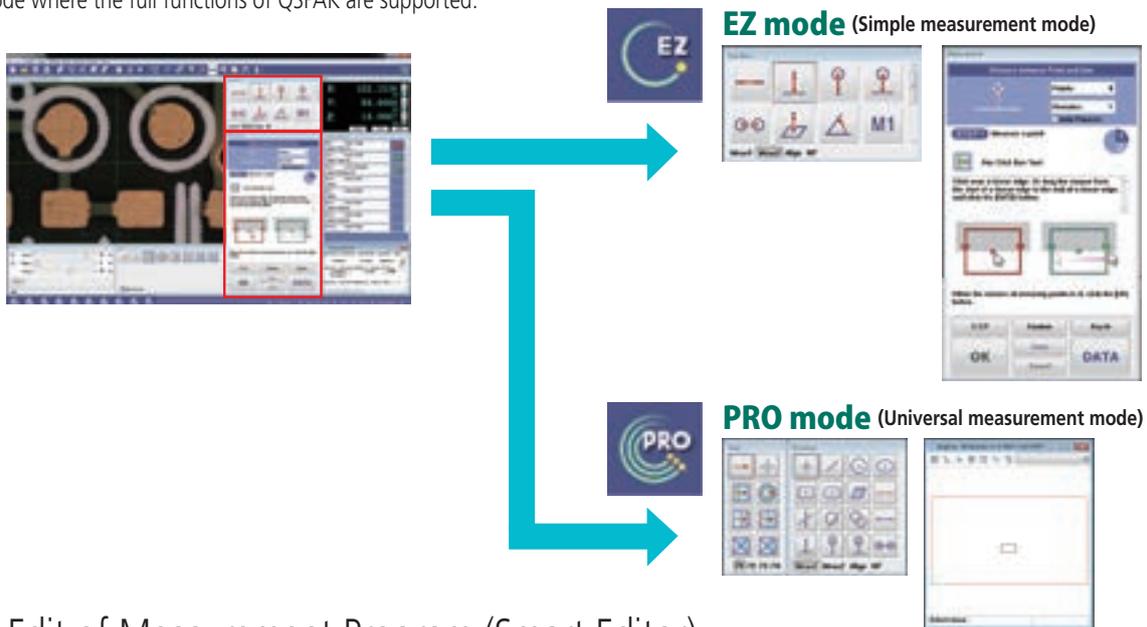
# Optional Accessories

Camera/Images

## Vision Unit Dedicated Software - QSPAK -

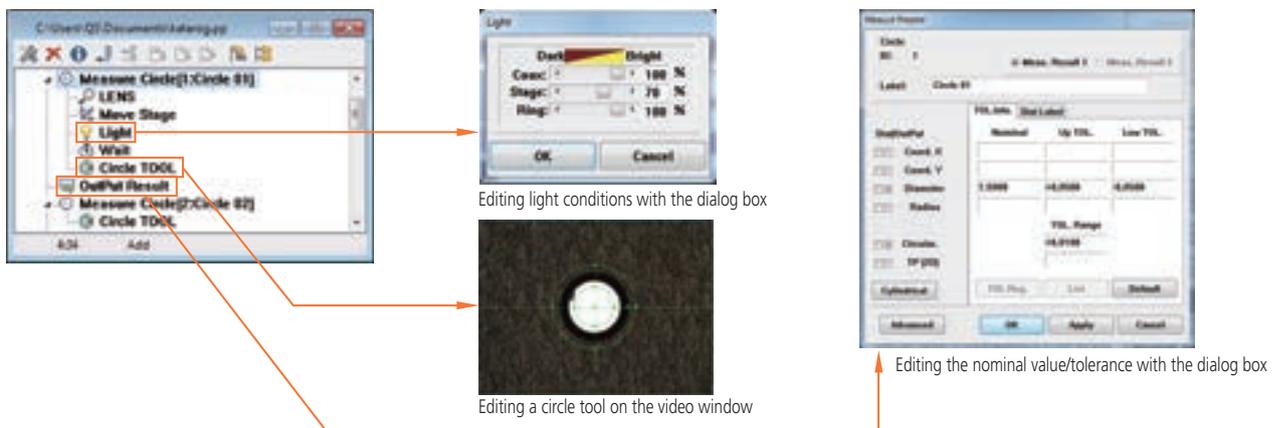
### Simple/Universal Mode Switching (EZ/PRO)

In the EZ mode for Simple & Operation guidance display, this software allows even a beginner to perform measurement without any confusion using the easy-to-understand measurement icons and guidance function. Also, it supports the needs of more advanced measurement by the ability to switch to the PRO mode where the full functions of QSPAK are supported.



### Simple Edit of Measurement Program (Smart Editor)

This function simply enables program correction/edit by only selecting an item you want to edit from among existing programs.



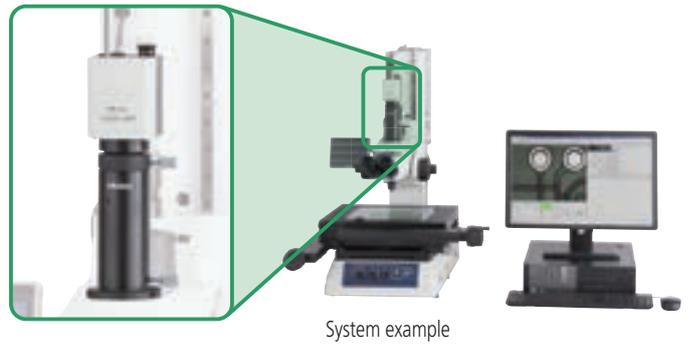
### Edge Detection Functions

- Outlier Removal Function**.....Removes outliers such as burrs and chips.
- Dual-area Contrast Tool**.....Automatically adjusts the light intensity of two areas to the optimum.
- Auto Trace Tool**.....Automatically detects contour data while predicting the next one.  
To perform contour analysis and contour tolerancing, use 2-dimensional analysis software (FORMTRACEPAK-AP).

# Optional Accessories

Camera/Images

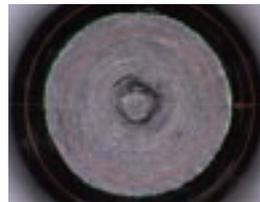
Vision Unit  
Dedicated Software - QSPAK -



System example

## Simplified Multi-point Measurement (One-click Tool)

A mere click on an edge allows correct measurement, avoiding the variation inherent in conventional multi-point measurement. The function to remove outliers such as burrs and chips can be used concurrently.



One-click circle tool



One-click box tool

## Graphics Function

This function automatically displays the current position, coordinate system, measurement feature and measurement result on the graphics window to prevent an omission or error of measurement from occurring. It also enables you to grasp which portion of the whole workpiece is observed by importing 2-dimensional CAD data\*.

\* Optional software (For details refer to Page 13.)

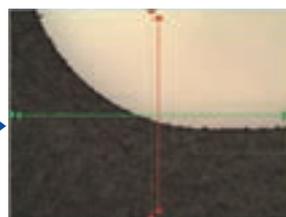


## Navigation Function (Quick Navigation)

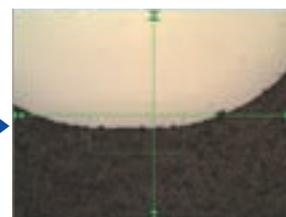
Once a measurement program is created, anyone can measure a workpiece just as well as skilled personnel by merely following the navigation instructions at the next measuring point.



(1) The next measuring point is indicated with red cross hairs.



(2) Approaching the measuring point, the red cross hairs and green cross hairs come close to each other.



(3) When both cross hairs overlap one another while indicating the target point, press the Input button to complete the measurement.

# Optional Accessories

Camera/Images

## Optional Software

### 2-dimensional Analysis Software - FORMTRACEPAK-AP -

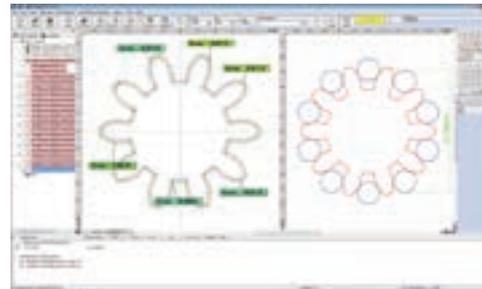
FORMTRACEPAK-AP allows contour analysis and comparative verification with the nominal value, making use of the point group data acquired with the auto trace tool.

Form analysis can be performed seamlessly from measured images with simple operations.



Example of form analysis

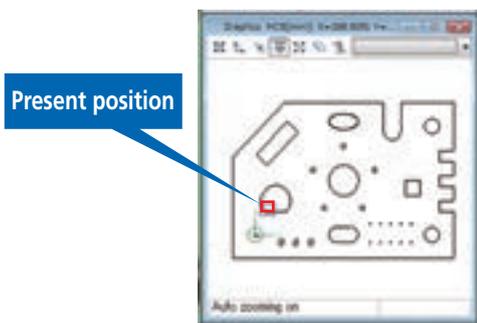
Contour tolerancing against the nominal value is also enabled. For example, the software allows over-pin diameter measurement by defining virtual circles with a given diameter around a gear.



Example of gear contour matching, and an over-pin diameter analysis

### Effective use of CAD model - QS-CAD I/F -

2-D CAD model data (DXF-, or IGES-formatted) can be imported into QIPAK. Conversely, QIPAK measurement results can be converted into 2-D CAD model data. The design value for each measurement item is automatically entered. Since the graphics window makes the present position easy to identify, the operator can quickly move the stage a given point in the 2-D CAD model.

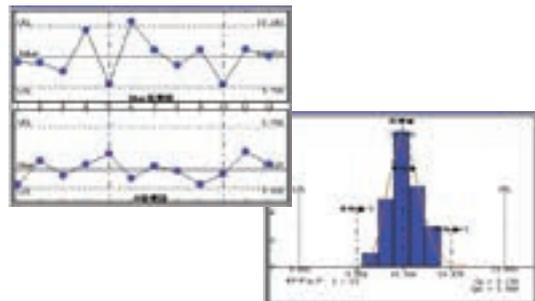


### Early detection of process irregularities - MeasurLink -

Statistical data can be displayed in real-time, making early detection of process irregularities possible. Early identification of an out-of-control situation enables rapid remedial action to be taken when necessary.

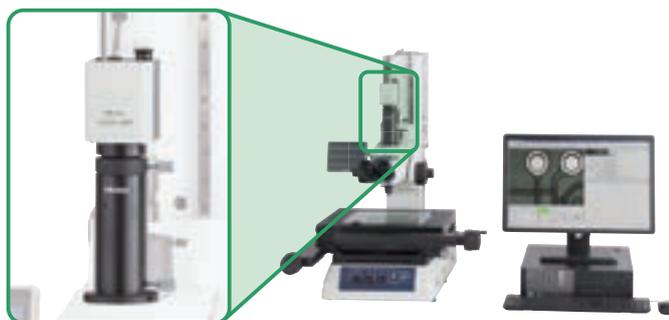
#### Examples of remedial action

- Mold repair or cycle-timing change
- Cutting tool adjustment or replacement.



# Optional Accessories

## Camera/Images



System example

## Specifications

Vision Unit 10D	
Order No.	<b>359-763</b>
Magnification of optical system	When installed on the microscope 0.5X (using the 0.5X TV adapter)
Image detection	High sensitivity 1/2-inch CMOS color camera with 300 million pixels
Resolution	0.1 $\mu\text{m}$
Measuring accuracy for each axis (in a 20°C environment)	Depends on measuring microscope
Accuracy (in a 20 °C environment)	Depends on measuring microscope Reference: when using a 3X ML objective (performing an inspection using our standard sample) Screen-internal repeatability (3 $\sigma$ ): $\pm 2.5 \mu\text{m}$ or less
PC system	Windows 10 64bit
Software	QSPAK VUE
Applicable model	<b>MF D/MF-U D</b>

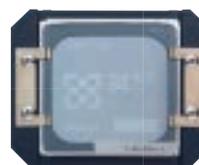
Note: Software (QSPAK VUE) and calculation processor are required separately.

## Calibration Chart

### Calibration Chart

This chart is used for pixel-size correction of the CCD, and auto-focus accuracy and optical-axis offset corrections for each selected magnification.

\* The function may be limited depending on the lens.  
For detailed information, contact a Mitutoyo sales office.



Order No. 02ATN695

## Others

### C-mount Adapter

This adapter is used to mount a C-mount compatible digital camera on the microscope main unit.



Order No. 970441

### 0.5X TV Adapter (including C-mount)

This adapter is used to mount a C-mount compatible digital CCD camera on the microscope main unit, thereby making an observation area on the monitor close to the real field of view through the objective.



Order No. 375-054

# Optional Accessories

Camera/Images

Calculation processing

## Data Processing Applications

### 2-dimesinal Data Processing Unit QM-Data200



Order No.: **264-155**  
 Application: QM-Data200 allows various data processing operations and creation of measurement programs without needing any other data processing unit.  
 Resolution: 0.1  $\mu\text{m}$   
 Program function: Creation, execution and editing of measurement procedures  
 Statistical processing: Measurement items, number of data, maximum value, minimum value, mean value, standard deviation, range, histogram and statistics by measurement function (statistics by command)  
 Display: TFTLCD (with LED backlight)  
 Tilting mechanism: Installed

### Foot Switch



Order No.: **12AAJ088**  
 Application: Foot switch for data transfer  
 A measurement result can be transferred to the data processing unit by stepping on the switch while holding the feed wheels.

# Optional Accessories

## Eyepieces/Optical Tubes

### Optical Tubes

Selectable Eyepiece Unit for MF series (One of the four options must be selected)

**Monocular Tube**  
Order No. 176-392



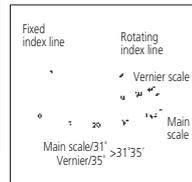
Simple, low-priced monocular tube.  
\* WF10X/24 eyepiece (1 pc.) equipped.

**Binocular Tube**  
Order No. 176-393



Binocular tube reduces eye fatigue.  
\* WF10X/24 eyepiece (2 pcs.) equipped.

**Protractor Eyepiece**  
Order No. 375-043



Graduation: 5'  
Measuring range: 360°  
The angle reading scale is built in, allowing angle measurement by simply rotating an index line between the features to be measured.  
\* Exclusive-use eyepiece is equipped (10X, Field number: 21)

**Digital Protractor Eyepiece**  
Order No. 176-313



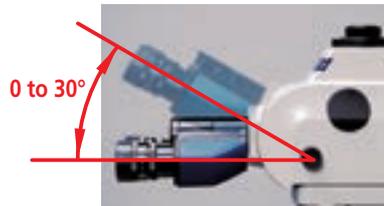
Magnification 10X, Field number 22  
Resolution: 0.01°/1' Switchable  
Measuring range: 0-369.99°  
An angle is measured by simply rotating the cross hairs. Eliminates misreading errors that can occur with the scale type.  
\* Exclusive-use eyepiece is equipped (10X, Field number: 22)

### High-performance optical tube\* for MF-U series

(MF-U Dedicated Standard Option)

Adjustable eyepiece angle enables the eye point to be adjusted according to operator physique, reducing eye strain and enabling comfortable observation.

\* WF10X/24 eyepiece (2 pcs.) equipped.



### Eyepieces

In addition to a standard accessory 10X lens, high magnification lenses, 15X and 20X, are available to suit various applications.



#### Eyepieces

	WF10X/24	WF20X/12
Order No. (1 piece)	378-866-5	378-858-5
Order No. (2 pieces)	378-866	378-858
Magnification	10X	20X
Field number	24	12

### Focus Detector Unit

Projecting an LED-generated chart pattern on the target enables easy and high-accuracy focusing, effectively reducing human and repetition errors in height measurement.

The concentric circle pattern and slit pattern can be switched. The color of the pattern is selectable from green and red to suit workpiece surface characteristics.



#### Focus Detector Unit Focus Pilot

Model No.	FP-05		FP-05U	
Order No.	375-057 (Green)	375-058 (Red)	375-067 (Green)	375-068 (Red)
Light source	Green LED or Red LED			
	• Concentric circle pattern		• Slit pattern	
	· The focal point is the position where the top and bottom of the pattern are aligned. · Pattern selection and brightness adjustment are enabled according to the surface status of a workpiece. · Observation with a wide field of view on a video monitor is available using 0.5X optical system (with a CCD camera mounted separately).			
Focusing reproducibility	Approximately 1.5 μm (when using a 20X lens)			
Applicable model	MF		MF-U	
	Note: In-company measured reference value of a sample			

# Optional Accessories

## Eyepieces/Optical Tubes

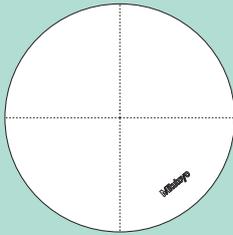


For MF D

For MF-U D

## Reticles

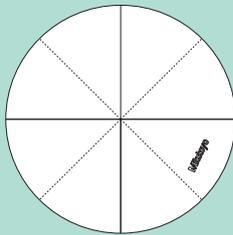
### Chain line type



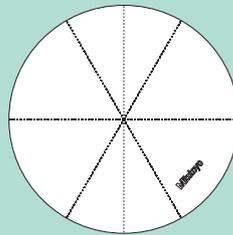
**12AAG838 (MF D)**  
**12AAG878 (MF-U D)**  
 90° chain lines  
 Chain line pitch: 0.2 to 0.2  
 Line width: 7 μm

**12AAG836 (MF D)**  
**12AAG877 (MF-U D)**  
 90° chain lines  
 Chain line pitch: 0.2 to 0.2  
 Line width: 5 μm

**12AAG873 (MF D)**  
**12AAG876 (MF-U D)**  
 90° chain lines  
 Chain line pitch: 0.2 to 0.2  
 Line width: 3 μm

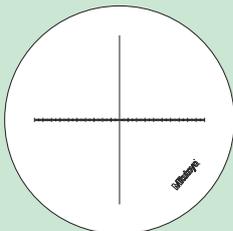


**12AAG839 (MF C/MF D)**  
**12AAG879 (MF-U D)**  
 90° solid lines, 45° chain lines  
 Chain line pitch: 0.2 to 0.2  
 Line width: 5 μm

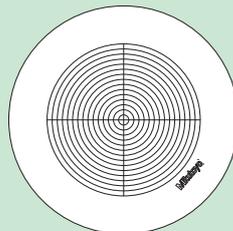


**12AAG840 (MF C/MF D)**  
**12AAG880 (MF-U D)**  
 90° chain lines, 60° chain lines  
 Chain line pitch: 0.2 to 0.2  
 Line width: 5 μm

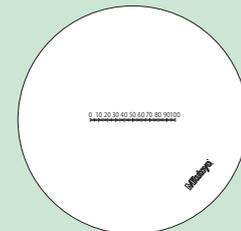
### Graduation line type (Objectives for MF series. Use these reticles with an eyepiece that has 10X magnification.)



**12AAG842 (MF D)**  
 Cross haired graduation lines  
 0.1/20 mm  
 Line width: 7 μm

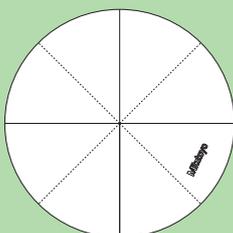


**12AAG843 (MF D)**  
 Concentric circles with graduation lines  
 ø1.2 to ø18  
 Line width: 7 μm



**12AAG844 (MF D)**  
 Graduation lines  
 0.1/10 mm  
 Line width: 10 μm

### Reticle for digital protractor eyepiece (included as standard)



90° solid lines, 45° chain lines  
 Chain line pitch: 0.2 to 0.2  
 Line width: 5 μm

Each reticle includes an insertion unit. Since the insertion unit is specific to the model, select applicable reticles for your microscope.

# Optional Accessories

## Objectives

### Objectives for MF Series

#### ML Objectives



#### ML Objectives

Model No.	Order No.	Magnification	Numerical Aperture (NA)	View field with eyepiece (mm)*1	View field with CCD camera (mm)*2	Resolving Power (μm)	Working distance (mm)	Depth of Focus ±D.F. (μm)
<b>ML 1X</b>	<b>375-036-2</b>	1X	0.03	ø24	12.8×9.6	9.2	61.0	306
<b>ML 3X</b>	<b>375-037-1</b>	3X	0.09	ø8	4.27×3.2	3.06	77.0	34
<b>ML 5X</b>	<b>375-034-1</b>	5X	0.13	ø4.8	2.56×1.92	2.12	61.0	16.3
<b>ML 10X</b>	<b>375-039</b>	10X	0.21	ø2.4	1.28×0.96	1.31	51.0	6.2
<b>ML 20X</b>	<b>375-051</b>	20X	0.42	ø1.2	0.64×0.48	0.65	20.0	1.6
<b>ML 50X</b>	<b>375-052</b>	50X	0.55	ø0.48	0.26×0.19	0.5	13.0	0.9
<b>ML 100X</b>	<b>375-053</b>	100X	0.70	ø0.24	0.13×0.10	0.4	6.0	0.6

\*1: View field with eyepiece is a view field when using eyepiece 10× (Standard accessory).

\*2: View field with CCD camera is a view field when using Mitutoyo Vision Unit (P10 to P14).

Compatible observation method: Bright-field observation

Advantage: A measurement error is reduced with the correct magnification.

The telecentric optical system is adopted for a magnification of 10X or less to reduce measurement error due to an out-of-focus condition.

#### Sliding Nosepiece (Factory-set Option)

Two ML objectives can be mounted, allowing stress-free change of magnification. Two types are available according to the switching specifications.

##### · Parfocal Type (Order No. **176-370-1**)

Since the focus of the two lenses, a reference lens (ML 3X) and the specified lens\*, are both pre-adjusted, focusing after switching the lens is unnecessary.

Note: The parfocal condition is not achieved with any lenses other than the specified combination.

##### · Magnification Type (Order No. **176-370-2**)

The magnification of two lenses is guaranteed in a combination of a reference lens (ML 3X) and pre-specified lens\*.

Recommended when using the guide-equipped reticle or comparison-measurement reticle.

Note: Blurring may occur when switching the lens.

\* Select a lens from the ML objective lenses other than ML 3X.



## Objectives for the MF-U Series



### M Plan Apo Objectives

Compatible observation method: Bright-field observation, simple polarized observation, differential interference observation

Advantage: Plan apochromat lenses free of spherical aberration/chromatic aberration are adopted to obtain images with excellent color reproducibility without blur over the entire field of view.

### G Plan Apo Objectives

Compatible observation method:

Observation through a cover glass

Advantage: Correction design is performed so as to obtain optimal observation images when observing through the glass.

(Corrected on the basis of BK7 and a cover glass thickness of 3.5 mm. Custom order of other glass material and thickness is also available.)



### BD Plan Apo Objectives

Compatible observation method: Bright-field observation, dark-field observation, simple polarized observation, differential interference observation

Advantage: Dark-field observation is also supported while maintaining the performance of the M Plan Apo objective series.

### FS objectives

Model No.	Order No.	Magnification	Numerical Aperture (NA)	View field with eyepiece (mm)	View field with CCD camera (mm)*	Resolving Power (μm)	Working distance (mm)	Depth of Focus ±D.F. (μm)
<b>M Plan Apo 1X</b>	<b>378-800-12</b>	1X	0.025	ø24	12.80×9.60	11	11.0	440
<b>M Plan Apo 2X</b>	<b>378-801-12</b>	2X	0.055	ø12	6.40×4.80	5	34.0	91
<b>M Plan Apo 5X</b>	<b>378-802-6</b>	5X	0.14	ø4.8	2.56×1.92	2	34.0	14
<b>M Plan Apo 7.5X</b>	<b>378-807-3</b>	7.5X	0.21	ø3.2	1.71×1.28	1.3	35.0	6.2
<b>M Plan Apo 10X</b>	<b>378-803-3</b>	10X	0.28	ø2.4	1.28×0.96	1	34.0	3.5
<b>M Plan Apo 20X</b>	<b>378-804-3</b>	20X	0.42	ø1.2	0.64×0.48	0.7	20.0	1.6
<b>M Plan Apo 50X</b>	<b>378-805-3</b>	50X	0.55	ø0.48	0.26×0.19	0.5	13.0	0.9
<b>M Plan Apo 100X</b>	<b>378-806-3</b>	100X	0.70	ø0.24	0.13×0.10	0.4	6.0	0.6
<b>M Plan Apo SL 20X</b>	<b>378-810-3</b>	20X	0.28	ø1.2	0.64×0.48	1	30.5	3.5
<b>M Plan Apo SL 50X</b>	<b>378-811-15</b>	50X	0.42	ø0.48	0.26×0.19	0.7	20.5	1.6
<b>M Plan Apo SL 100X</b>	<b>378-813-3</b>	100X	0.55	ø0.24	0.13×0.10	0.5	13.0	0.9
<b>M Plan Apo HR 50X</b>	<b>378-814-4</b>	50X	0.75	ø0.48	0.26×0.19	0.4	5.2	0.49
<b>M Plan Apo HR 100X</b>	<b>378-815-4</b>	100X	0.90	ø0.24	0.13×0.10	0.3	1.3	0.34
<b>G Plan Apo 20X (t3.5)</b>	<b>378-847</b>	20X	0.28	ø1.2	0.64×0.48	1	Air conversion 29.42	3.5
<b>G Plan Apo 50X (t3.5)</b>	<b>378-848-3</b>	50X	0.50	ø0.48	0.26×0.19	0.6	Air conversion 13.89	1.1

\* View field with CCD camera is a view field when using Mitutoyo Vision Unit (P10 to P14).

Note: SL: Super long working distance model

HR: High Resolution model

Model No.	Order No.	Magnification	Numerical Aperture (NA)	View field with eyepiece (mm)	View field with CCD camera (mm)*	Resolving Power (μm)	Working distance (mm)	Depth of Focus ±D.F. (μm)
<b>BD Plan Apo 2X</b>	<b>378-831-12</b>	2X	0.055	ø12	6.40×4.80	5	34.0	91
<b>BD Plan Apo 5X</b>	<b>378-832-7</b>	5X	0.14	ø4.8	2.56×1.92	2	34.0	14
<b>BD Plan Apo 7.5X</b>	<b>378-830-7</b>	7.5X	0.21	ø3.2	1.71×1.28	1.3	34.0	6.2
<b>BD Plan Apo 10X</b>	<b>378-833-7</b>	10X	0.28	ø2.4	1.28×0.96	1	34.0	3.5
<b>BD Plan Apo 20X</b>	<b>378-834-7</b>	20X	0.42	ø1.2	0.64×0.48	0.7	20.0	1.6
<b>BD Plan Apo 50X</b>	<b>378-835-7</b>	50X	0.55	ø0.48	0.26×0.19	0.5	13.0	0.9
<b>BD Plan Apo 100X</b>	<b>378-836-7</b>	100X	0.70	ø0.24	0.13×0.10	0.4	6.0	0.6

\* View field with CCD camera is a view field when using Mitutoyo Vision Unit (P10 to P14).

### Turret



Manual turret for Bright-field and dark-field (4 ways)

Manual turret for Bright-field (4 ways)



Power turret for Brightfield and dark-field (4 ways)



Mounting example of power turret (No. 378-216)

Supported observation	Bright field (M Plan Apo/G Plan Apo)		Bright and dark field (BD Plan Apo)	
	Order No.	Order No.	Order No.	Order No.
Driving method	Manual	Power	Manual	Power
Number of ways	4	5	4	4
Aligning/Parfocal mechanism	Aligning/Parfocal	Aligning	—	—

\* When using the turret without parfocal mechanism and objectives, it is recommended to concurrently use "Parfocal Adjustment SIMM Set" (for bright-field observation: Order No. 378-089, for dark-field observation: Order No. 378-090).

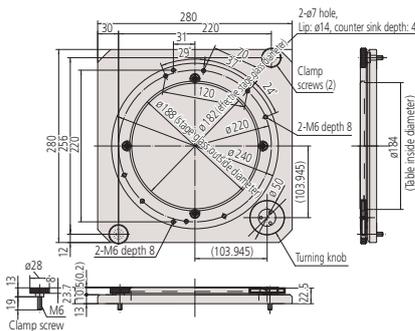
# Optional Accessories

## Rotary tables

### Rotary table with Fine Wheel (A)



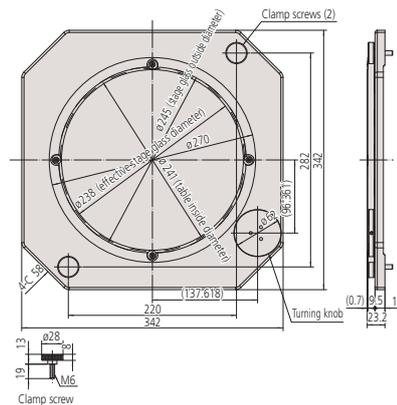
Order No.: **176-305**  
 Application: Workpiece orientating/positional fine-adjustment  
 External dimension: 280 (W)×280 (D)×23.7 (H) mm  
 Tabletop: ø240 mm, 360° rotation, no angle scale  
 Mass: 5.5 kg  
 Effective glass diameter (mm): ø182  
 Applicable model: Size 1010, 2010 (**MF/MF-U series**)  
 \* Option: 172-197 Swivel Center Support  
 176-107 Holder with Clamp  
 172-378 V-block with Clamp



### Rotary table with Fine Wheel (B)

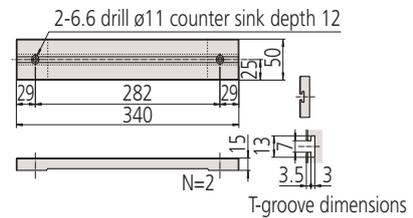


Order No.: **176-306**  
 Application: Workpiece orientating/positional fine-adjustment  
 External dimension: 342 (W)×342 (D)×23.2 (H) mm  
 Tabletop: ø270 mm, 360° rotation, no angle scale  
 Mass: 6.5 kg  
 Effective glass diameter (mm): ø238  
 Applicable model: Size 2017, 3017, 4020 (**MF/MF-U series**)  
 \* The V-block with Clamp, Swivel Center Support and Holder with Clamp can NOT be mounted on the table.

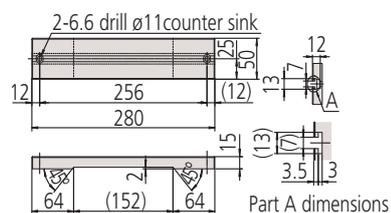


### Stage Adapter

Order No.: Stage Adapter: **176-304**  
 Stage Adapter B: **176-310**  
 Application: Used when setting the workpiece fixture on the stage.  
 External dimensions for one piece:  
 50 (W)×340 (D)×15 (H) mm  
 \*Note Adapter B is 280 (D)  
 Mass: Stage Adapter: 1.5 kg  
 Stage Adapter B: 1.2 kg



176-304 Stage Adapter



176-310 Stage Adapter

		Stage size		
		1010	2010	2017 3017 4020
<b>176-304</b>	Stage Adapter	—	Not applicable	Applicable
<b>176-310</b>	Stage Adapter B	—	Applicable	Not applicable

Note: Not required for model 1010.

# Optional Accessories

Others

## Holder with Clamp



Order No.: **176-107**

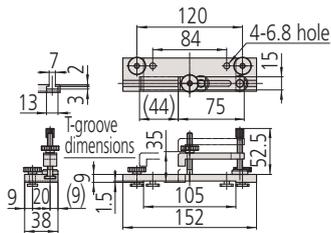
Application: Used to clamp a thin workpiece such as a PCB or pressed part.

Maximum clamp length: 35 mm

External dimensions: 62 (H)×152 (W)×38 (D) mm

Mass: 0.4 kg

\* Note: Size 2010 is used with stage adapter B. Sizes 2017, 3017, and 4020 are usable with stage adapter



## V-block with Clamp



Order No.: **172-378**

Maximum clamping diameter:  $\phi 25$  mm

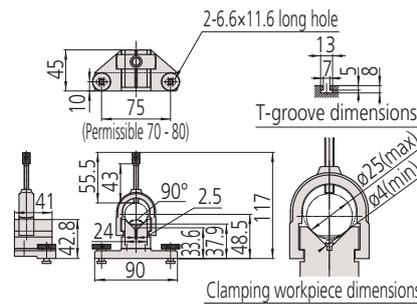
Height from the mounting surface to the center: 38-48 mm

Application: Used to mount a cylindrical-form workpiece.

External dimensions: 117 (H)×90 (W)×45 (D) mm

Mass: 0.8 kg

\* Note: Size 2010 is used with stage adapter B. Sizes 2017, 3017, and 4020 are usable with stage adapter



## Swivel Center Support



Order No.: **172-197**

$\pm 10^\circ$  for swivel position

Maximum angle index:  $1^\circ$

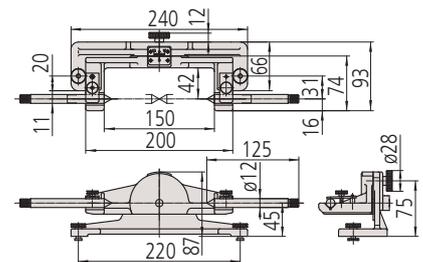
Application: Used to mount a center-machined workpiece for measurement of screw pitch diameter, depth, etc.

Maximum horizontal clamping size:  $\phi 80 \times 140$  mm

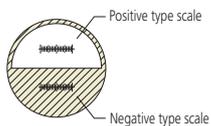
Maximum clamping size when inclined  $10^\circ$ :  $\phi 65 \times 140$  mm

Mass: 2.5 kg

\* Note: Size 2010 is used with stage adapter B. Sizes 2017, 3017, and 4020 are usable with stage adapter



## Stage Micrometer



Order No.: **375-056**

Scale length: 1 mm

Application: For verifying magnification of objective lens

Minimum graduation: 0.01 mm

Scale accuracy (20 °C): 1+L ( $\mu$ m) L: length between any two lines (mm)

External dimensions: 76 (W)×26 (D) mm

Mass: 16 g

\* Note: After purchasing the product, we perform calibration. For details, contact your nearest Mitutoyo Sales Office.

## Mounting Stand (for Microscope)



Order No.: **176-309**

Application: Microscope main unit mounting stand

Maximum loading: 300 kg

External dimensions: 1200 (W)×900 (D)×650 (H) mm

Mass: Approximately 50 kg

Applicable model: **MF/MF-U**

\* Note: When specifying a microscope with the Vision Unit, we recommend selecting the large mounting stand No. **02ATE760**, which has external dimensions of 1,800 (W)×900 (D)×740 (H) mm.

## Vibration Damping Stand



Order No.: **176-308**

Application: Microscope vibration isolation table

Supporting method: Spring pad

Maximum loading: 200 kg

External dimensions: 750 (W)×550 (D)×36 (H) mm

Mass: 36 kg

Applicable model: **MF/MF-U**

# Optional Accessories

## Internal light source

### LED Illumination Unit

The LED illumination unit has a longer operating life than a halogen bulb. This reduces running costs and saves the trouble of replacing the bulb. Also, a quick response to light control allows stress-free search for the illumination condition best suited to a workpiece.

For MF series: Transmitted/Reflected illumination Set **Order No. 176-445**

For MF-U series: Transmitted/Reflected illumination Set **Order No. 176-446**



Order No. 176-445

### Halogen Illumination Unit

Select this illumination unit when measuring a low-reflectivity workpiece rather than the standard LED illumination unit.

For MF series: Transmitted/Reflected illumination Set **Order No. 176-447**

For MF-U series: Transmitted **Order No. 176-448**

Reflected 100 W (Standard) **Order No. 176-315**

150 W (High brightness) **Order No. 176-316**



Order No. 176-447



Order No. 176-316

### Spare lighting

Select high-brightness or long-life lighting according to your application.

Applicable model	Applicable model	Illumination method	High-brightness type	Long-life type
MF	<b>176-447</b>	Transmitted/reflected	513667	12BAB345
	<b>176-448</b>	Transmitted	513667	12BAB345
MF-U	<b>176-315</b>	Reflected (100 W)	12BAD602	517181
	<b>176-316</b>	Reflected (150 W)	12BAJ075	12BAJ076
External light source	<b>176-366 / 176-343</b>	—	12BAD602	517181

### Illumination filter

Select the optimal filter depending on the intended use.

GIF filter: Emphasizes contrast in the image.

LB filter: Converts the warm-colored halogen light to a more natural color.

ND filter: Reduces illumination intensity without changing the observation condition (color temperature) in spite of the fact that halogen light becomes redder when darkened by decreasing the voltage.

ND2: Light intensity 1/2 (transmission factor 50 %) ND8: Light intensity 1/8 (transmission factor 12.5 %)

Light source	Applicable model	Order No.	Illumination method	GIF	LB80	ND2	ND8
LED illumination	MF	<b>176-445</b>	Transmitted/reflected	12AAA645	—	—	—
	MF-U	<b>176-446</b>					
Halogen illumination	MF	<b>176-447</b>	Transmitted/reflected	12AAA645	12AAA646	12AAA643	12AAA644
		<b>176-448</b>	Transmitted				
	MF-U	<b>176-315</b>	Reflected (100 W)	12AAG806	12AAG807	—	—
		<b>176-316</b>	Reflected (150 W)	—	—	—	—



# Optional Accessories

## External light source

### LED Ring Light

For MF series : **Order No. 176-367-2** (Standard)  
 : **Order No. 176-371** (Specific to Sliding Nosepiece)  
 For MF-U series : Please contact with your local Mitutoyo Sales Office.

This illumination unit provides a high image contrast for observation of deep-color resins, PCBs and small-diameter cylinders, thus providing optimal performance for vision measurement. Even if the brightness of illumination is changed, no color will change.

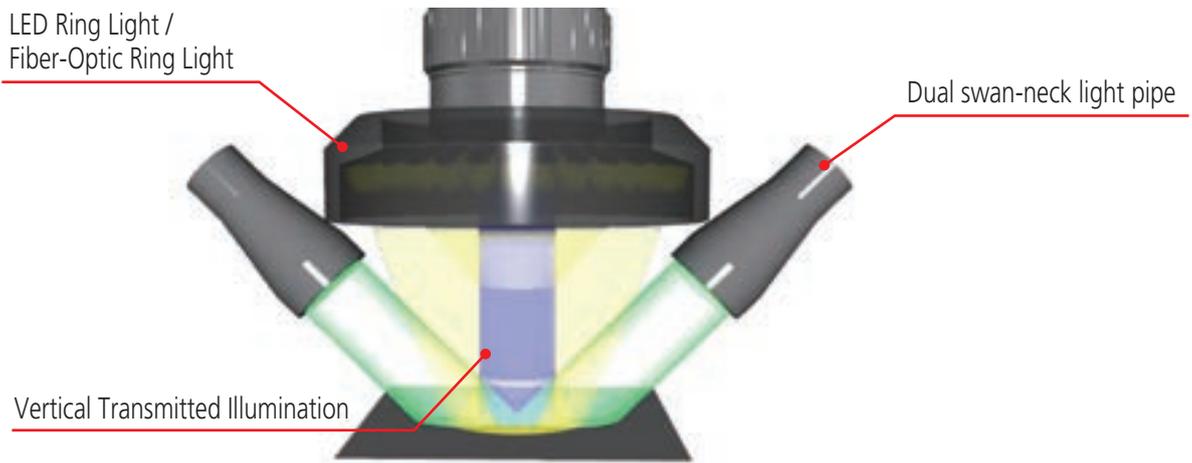
\* The ring light illumination is compatible with ML objectives of 10X or less. If an objective with a magnification of more than 10X is used, there is a risk of difficulties in observation due to insufficient light intensity.



Mounted on MF series



Mounted on MF-U series

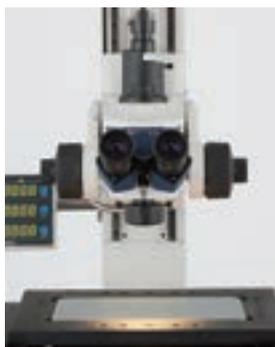


### Fiber-Optic Ring Light

For MF series: **Order No. 176-366** (Standard)

The Fiber-Optic Ring Light is the best unit to use when a bright, shadowless image is required. This illumination is best suited to observation at high magnifications and vision measurement.

\* The ring light illumination is compatible with ML objectives of 10X or less. If an objective with a magnification of more than 10X is used, there is a risk of difficulties in observation due to insufficient light intensity.



### Dual swan-neck light pipe

For MF and MF-U series: **Order No. 176-343**

This illumination unit highlights the features of a workpiece surface by applying oblique light to it, forming shadows which aid viewing. High-brightness spot lighting is also available by the concurrent use of the standard-supplied condenser lens.



# Specifications

## MF Series

### Manual Models

Main unit		1010	2010	2017	3017	4020
Without Z-axis scale		<b>MF-A1010D</b> 176-861*1	<b>MF-A2010D</b> 176-862*1	<b>MF-A2017D</b> 176-863*1	<b>MF-A3017D</b> 176-864*1	<b>MF-A4020D</b> 176-865*1
With Z-axis scale		<b>MF-B1010D</b> 176-866*1	<b>MF-B2010D</b> 176-867*1	<b>MF-B2017D</b> 176-868*1	<b>MF-B3017D</b> 176-869*1	<b>MF-B4020D</b> 176-870*1
Measuring accuracy*2 (20 °C, when not loaded)		(2.2+0.02L) μm L: measuring length (mm)				
Minimum reading		High accuracy digital scale is mounted 1/0.5/0.1 μm switchable				
Observation	Optical tube	Monocular or binocular TV camera port for all models (observation/TV camera = 50/50)*4 is provided as standard Reticle (broken cross-hair, line width: 5 μm) is provided as standard Various reticles are optional.				
	Incline angle	Angle of column: 25°				
	Observation image	Erect image				
	Observation method	Bright-field observation				
Eyepiece		10X (eyepiece field number: 24) is provided as standard 15X, 20X, Angle eyepieces 10X, Digital angle eyepieces 10X are optional.				
Objective		3X (working distance: 77 mm) is provided as standard 1X, 5X, 20X, 50X, 100X, a pair of sliding nosepieces*5 are optional.				
Stage	Measuring range	100x100 mm	200x100 mm	200x170 mm	300x170 mm	400x200 mm
	Max. table loading	10 kg		20 kg		15 kg
	Feed mechanism	Manual and Quick-release mechanism (zero-set switch is incorporated)				
	Swiveling angle	—		±5°		±3°
Internal light source	• LED Illumination Unit	White LED (transmitted/vertical reflected), no step modulated light				
	• Halogen Illumination Unit	12 V, 50 W halogen (transmitted/vertical reflected), no step modulated light				
External light source		Ring light and dual swan-neck light pipe are optional.				
Z axis	Feed mechanism	Coaxial coarse and fine feed, handles on both sides (coarse: 30 mm/rotation, fine: 0.2 mm/rotation)				
	Max. workpiece height	150 mm		220 mm		
Dimensions (WxDxH)	Main unit	562x730x667 mm	624x745x667 mm	642x892x782 mm	692x892x782 mm	756x892x782 mm
	Control unit	—				
	Control unit for illumination unit	114x360x96 mm				
Output		RS-232C output, USB output for Vision Unit				
Mass		Approx. 70 kg	Approx. 75 kg	Approx. 150 kg	Approx. 160 kg	Approx. 165 kg
Max. power consumption*3		LED: 45 W Halogen: 160 W AC power input connector: 100 to 240 V				

### Motor-Driven Z-axis Models

Main unit		1010	2010	2017	3017	4020
With Z-axis scale				<b>MF-J2017D</b> 176-891*1	<b>MF-J3017D</b> 176-892*1	<b>MF-J4020D</b> 176-893*1
Z axis	Feed mechanism	Motor drive (Maximum measuring speed: 20 mm/s), lower limit setting (for collision avoidance with a workpiece)				
	Max. workpiece height	220 mm				
Dimensions (WxDxH)	Main unit			642x892x782 mm	692x892x782 mm	756x892x782 mm
	Control unit	355x364x106.5 mm				
	Control unit for illumination unit	114x360x96 mm				
Output		RS-232C output, USB output for Vision Unit				
Mass				Approx. 160 kg	Approx. 170 kg	Approx. 175 kg
Max. power consumption*3		LED: 275 W Halogen: 390 W AC power input connector: 100 to 240 V				

Note: The specification other than the above is subject to the manual models.

• Required optional accessory

\*1 To denote your AC power cable add the following suffixes to the order No.: A for UL/CSA, D for CEE, DC for CCC, E for BS, K for KC, C and No suffix are required for PSE.

\*2 Measured in conformance with JIS B 7153

\*3 Optional accessory is NOT target (Main unit and required optional illumination are target)

\*4 C mount is required separately.

\*5 A pair of Sliding Nosepieces are factory-installed option.

# MF-U Series

## Manual Models

Main unit		1010	2010	2017	3017	4020
BF (Bright-field)	Without Z-axis scale	<b>MF-UA1010D</b> 176-871*1	<b>MF-UA2010D</b> 176-872*1	<b>MF-UA2017D</b> 176-873*1	<b>MF-UA3017D</b> 176-874*1	<b>MF-UA4020D</b> 176-875*1
	With Z-axis scale	<b>MF-UB1010D</b> 176-876*1	<b>MF-UB2010D</b> 176-877*1	<b>MF-UB2017D</b> 176-878*1	<b>MF-UB3017D</b> 176-879*1	<b>MF-UB4020D</b> 176-880*1
BD (Bright/ Dark-field)	Without Z-axis scale	<b>MF-UC1010D</b> 176-881*1	<b>MF-UC2010D</b> 176-882*1	<b>MF-UC2017D</b> 176-883*1	<b>MF-UC3017D</b> 176-884*1	<b>MF-UC4020D</b> 176-885*1
	With Z-axis scale	<b>MF-UD1010D</b> 176-886*1	<b>MF-UD2010D</b> 176-887*1	<b>MF-UD2017D</b> 176-888*1	<b>MF-UD3017D</b> 176-889*1	<b>MF-UD4020D</b> 176-890*1
Measuring accuracy*2 (20 °C, when not loaded)		(2.2+0.02L) μm L: measuring length (mm)				
Minimum reading		High accuracy digital scale is mounted 1/0.5/0.1 μm switchable				
Observation	Optical tube	Tilting optical tube is provided as standard TV camera port for all models (observation/TV camera = 50/50*4 is provided as standard Reticle (broken cross-hair, line width: 5 μm) is provided as standard Various reticles are optional.				
	Incline angle	Angle of column: 0-30°				
	Observation image	Erect image				
	Observation method	Bright-field observation/Dark-field observation (Only for MF-UC and MF-UD types) Simple polarization and differential interference are optional.				
Eyepiece		10X (eyepiece field number: 24) is provided as standard 15X, 20X are optional.				
Turret		Manual, motor drive				
Objective		M Plan Apo, G Plan Apo series BD Plan Apo series				
Stage	Measuring range	100×100 mm	200×100 mm	200×170 mm	300×170 mm	400×200 mm
	Max. table loading	10 kg		20 kg		15 kg
	Feed mechanism	Manual and Quick-release mechanism (zero-set switch is incorporated)				
	Swiveling angle	—			±5°	±3°
Internal light source	• LED Illumination Unit	White LED (transmitted/vertical reflected), no step modulated light 12 V, 50 W halogen (transmitted), no step modulated light 12 V, 100 W (vertical reflected), no step modulated light**5				
	• Halogen Illumination Unit	15 V, 150 W (vertical reflected), no step modulated light are optional.*5				
External light source		Dual swan-neck light pipe are optional.				
Z axis	Feed mechanism	Manual handles on both sides (coarse: 30 mm/rotation, fine: 0.2 mm/rotation)				
	Max. workpiece height	150 mm			220 mm	
Dimensions (W×D×H)	Main unit	562×730×667 mm	624×745×667 mm	642×892×782 mm	692×892×782 mm	756×892×782 mm
	Control unit	—				
	Control unit for illumination unit	114×360×96 mm				
Output		RS-232C output, USB output for Vision Unit				
Mass		Approx. 70 kg	Approx. 75 kg	Approx. 150 kg	Approx. 160 kg	Approx. 165 kg
Max. power consumption*3		LED: 55 W Halogen: 190 W (vertical reflected 12 V, 100 W) and 240 W (vertical reflected 15 V, 150 W) AC power input connector: 100 to 240 V				

## Motor-Driven Z-axis Models

Main unit		1010	2010	2017	3017	4020
BF (Bright-field)	With Z-axis scale			<b>MF-UJ2017D</b> 176-894*1	<b>MF-UJ3017D</b> 176-895*1	<b>MF-UJ4020D</b> 176-896*1
	BD (Bright/Dark-field)			<b>MF-UK2017D</b> 176-897*1	<b>MF-UK3017D</b> 176-898*1	<b>MF-UK4020D</b> 176-899*1
Z axis	Feed mechanism	Motor drive (Maximum measuring speed: 20 mm/s), lower limit setting (for collision avoidance with a workpiece)				
	Max. workpiece height	220 mm				
Dimensions (W×D×H)	Main unit			642×892×782 mm	692×892×782 mm	756×892×782 mm
	Control unit	355×364×106.5 mm				
	Control unit for illumination unit	114×360×96 mm				
Output		RS-232C output, USB output for Vision Unit				
Mass				Approx. 160 kg	Approx. 170 kg	Approx. 175 kg
Max. power consumption*3		LED: 285 W Halogen: 420 W (vertical reflected 12 V, 100 W) and 470 W (vertical reflected 15 V, 150 W) AC power input connector: 100 to 240 V				

Note: The specification other than the above is subject to the manual models.

• Required optional accessory

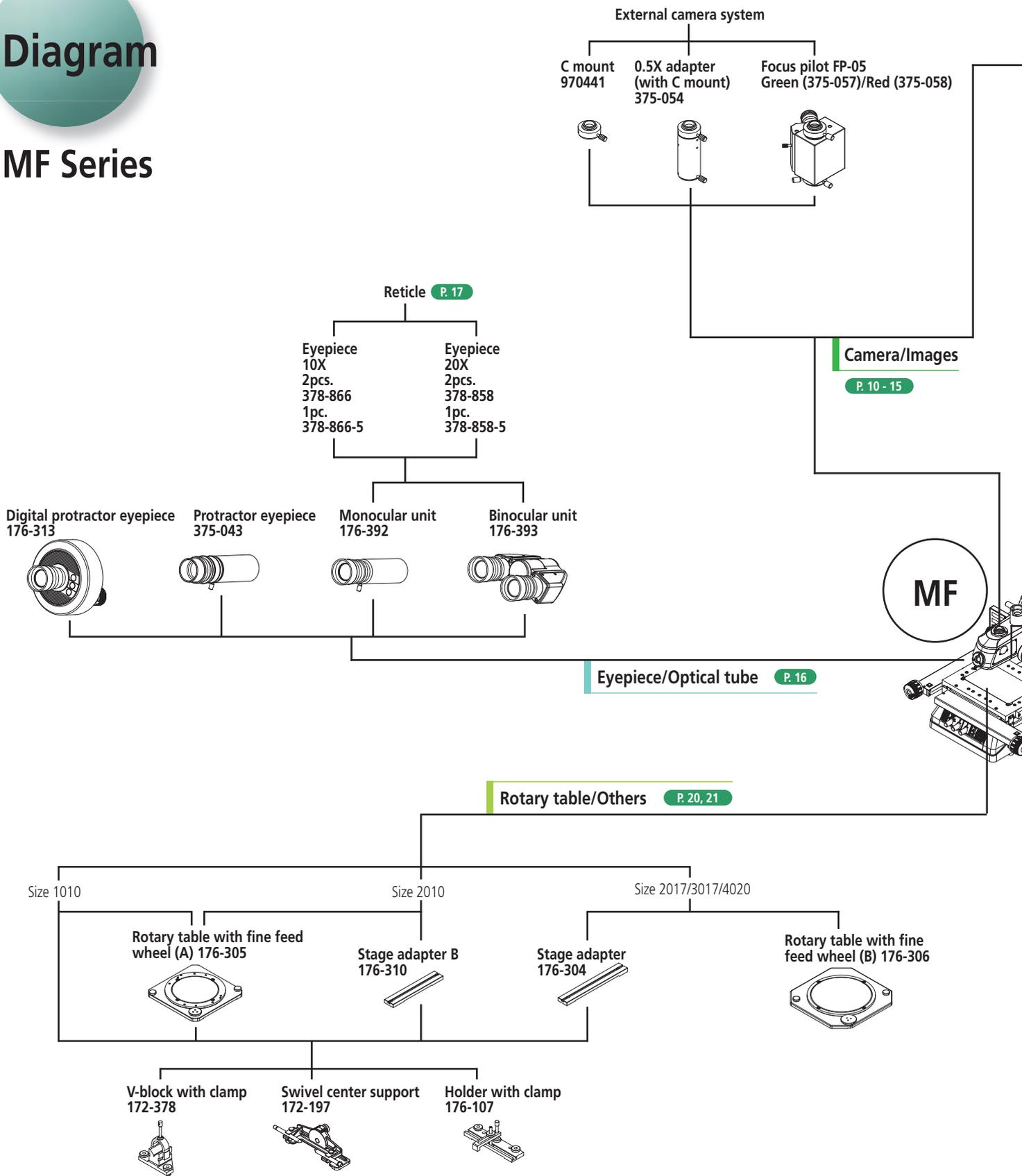
\*1 To denote your AC power cable add the following suffixes to the order No.: A for UL/CSA, D for CEE, DC for CCC, E for BS, K for KC, C and No suffix are required for PSE.

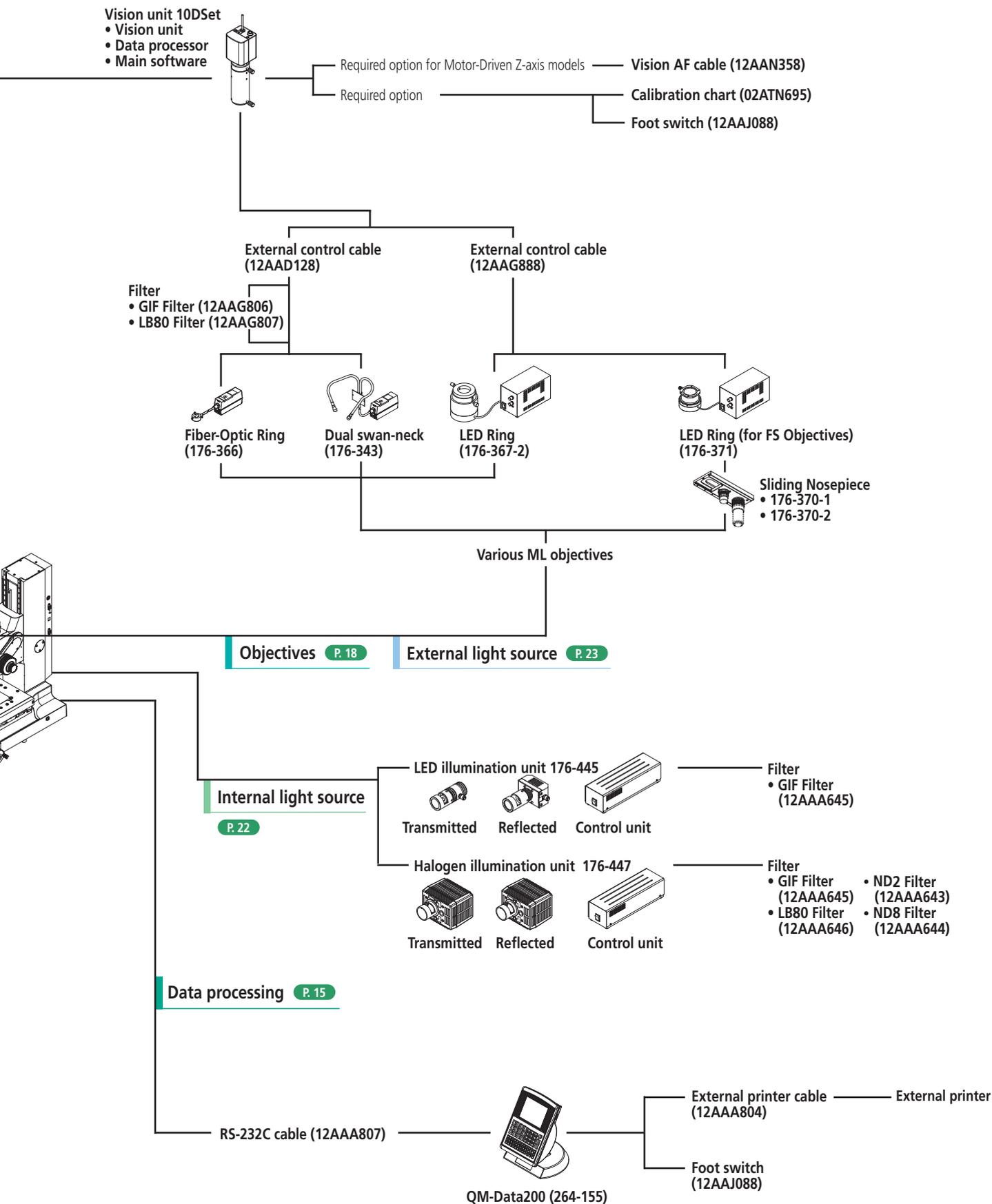
\*2 Measured in conformance with JIS B 7153 \*3 Optional accessory is NOT target (Main unit and required optional illumination are target)

\*4 C mount is required separately. \*5 Select either one

# Diagram

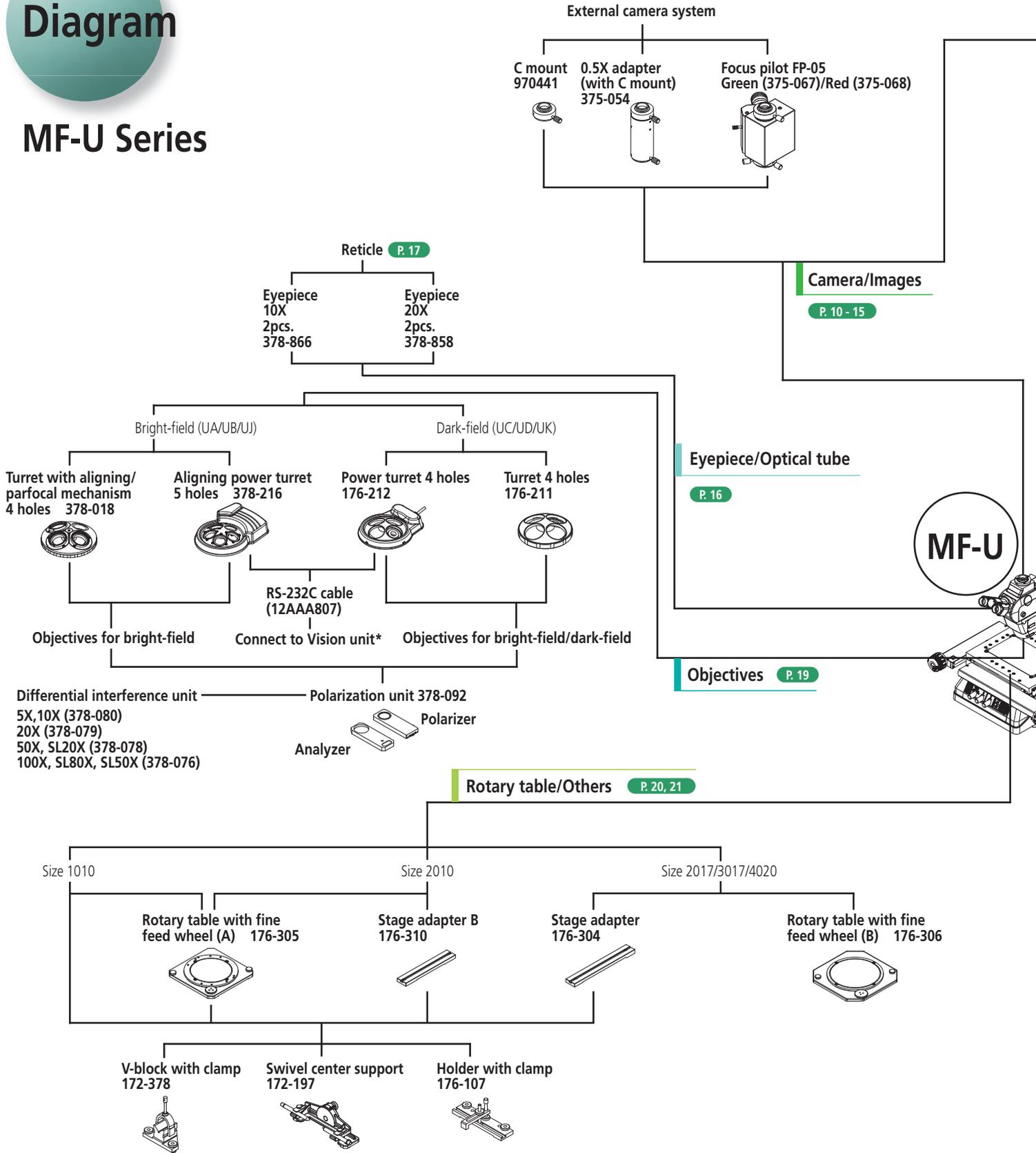
## MF Series

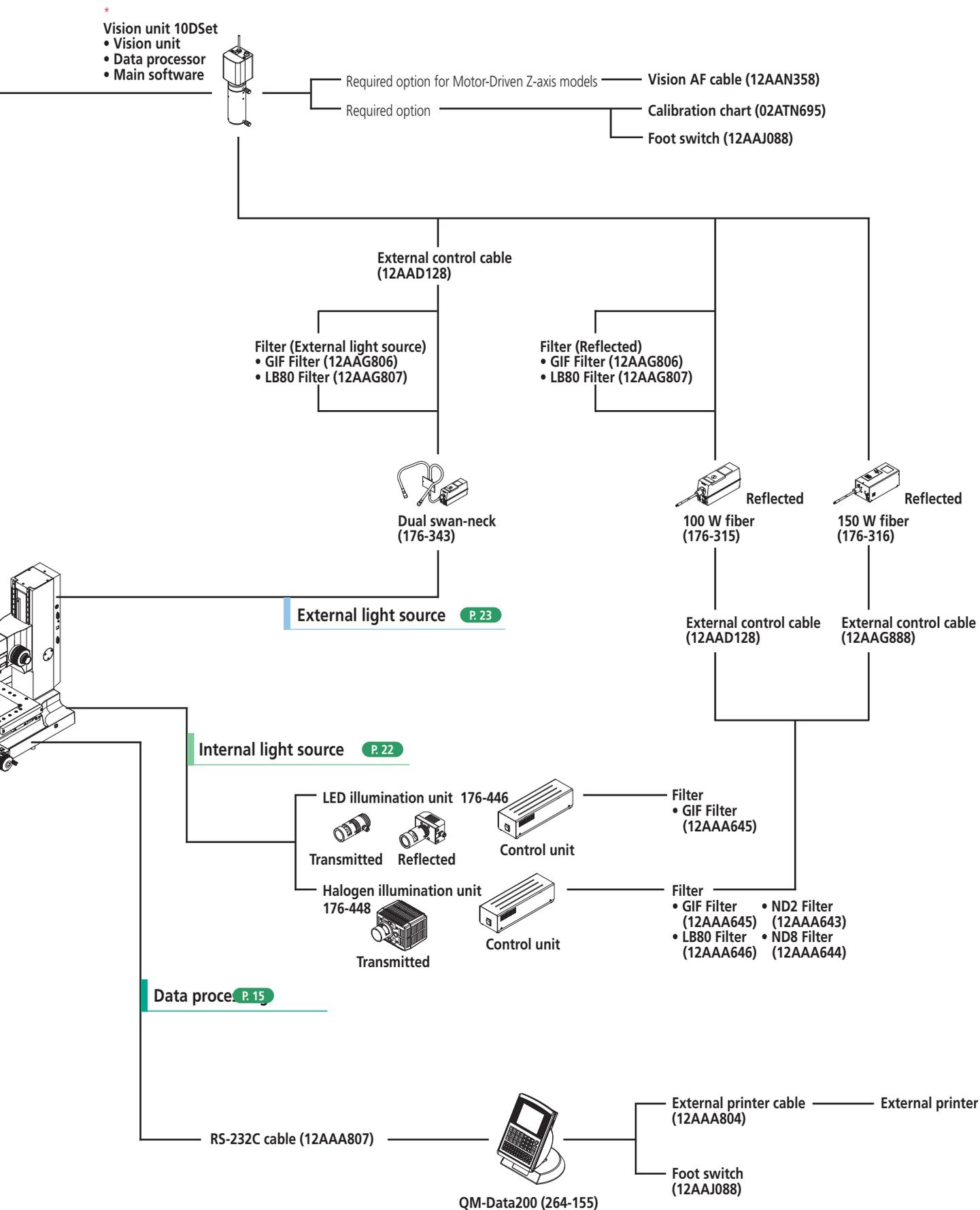




# Diagram

## MF-U Series





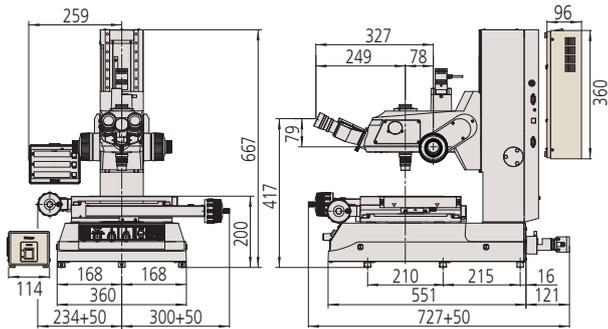
# Dimensions

## MF Series

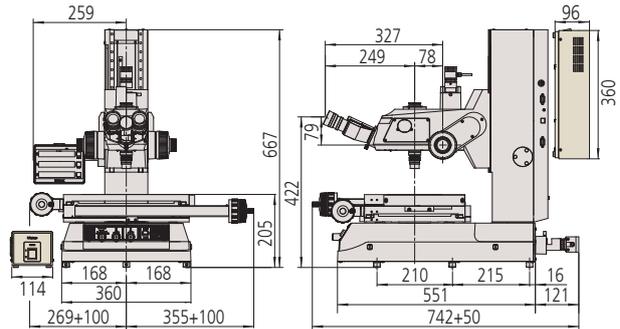
Manual Models \* Common dimensions for MF-A and MF-B models.

Unit: mm

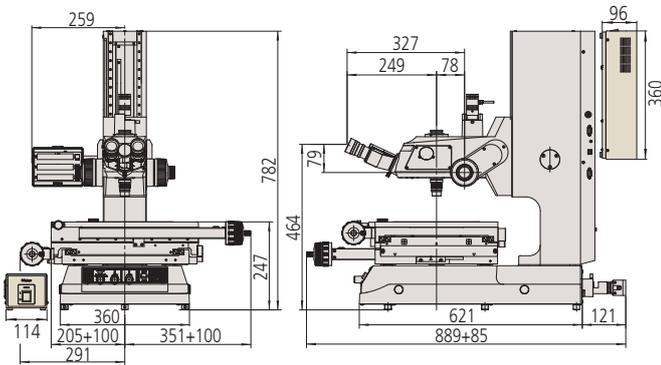
MF-B1010D



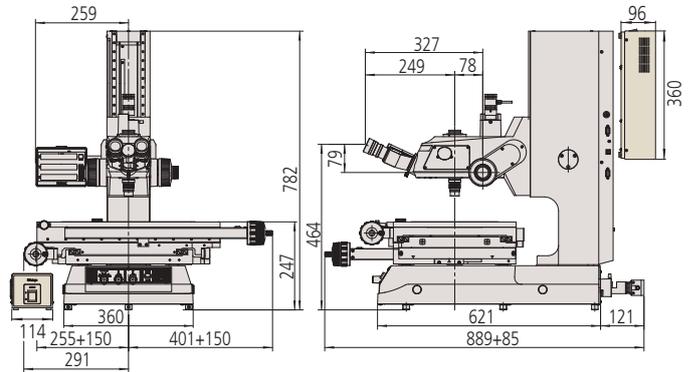
MF-B2010D



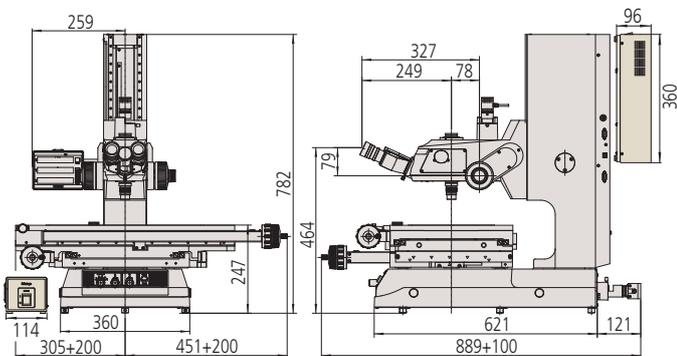
MF-B2017D



MF-B3017D



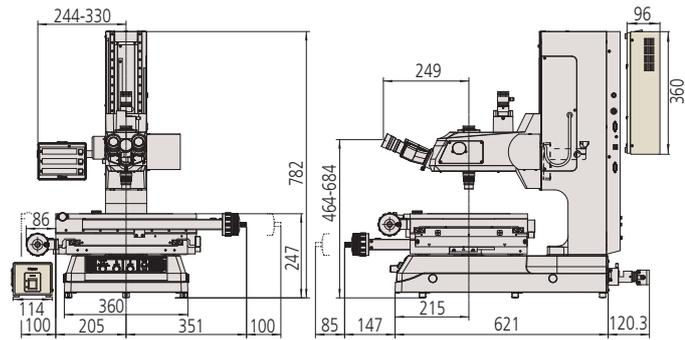
MF-B4020D



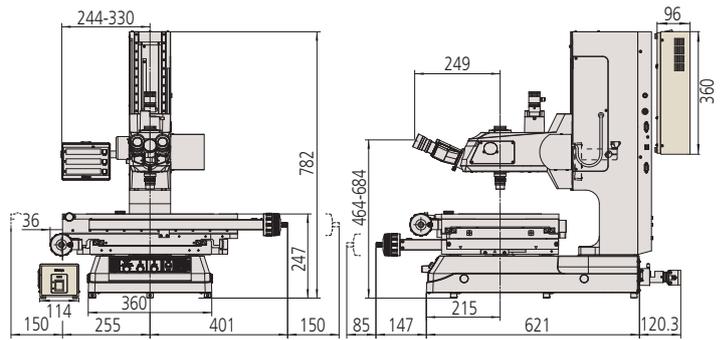
## Motor-Driven Z-axis Models

Unit: mm

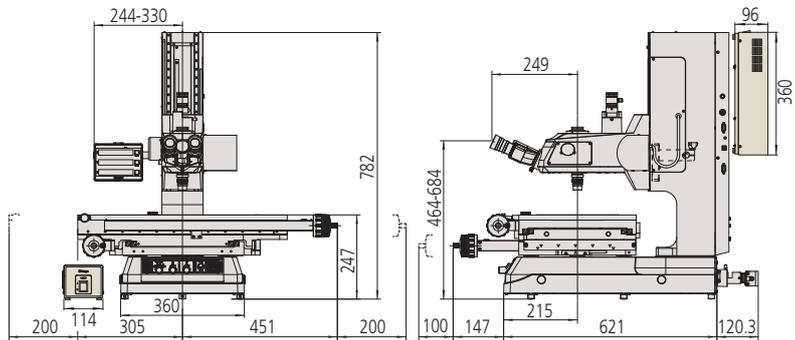
MF-J2017D



MF-J3017D



MF-J4020D



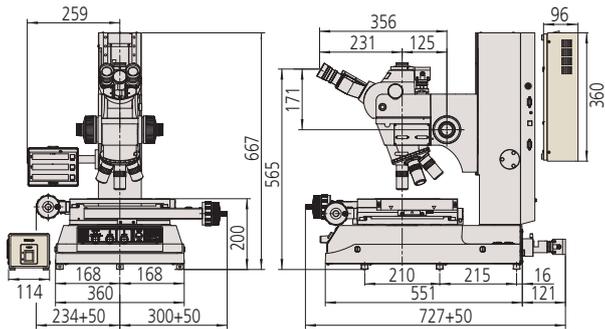
# Dimensions

## MF-U Series

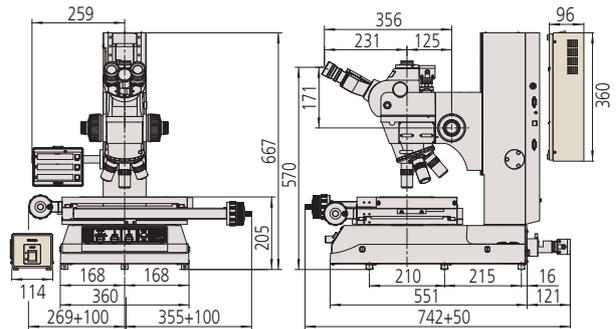
Manual Models \* Common dimensions for MF-UA, MF-UB, MF-UC, and MF-UD models.

Unit: mm

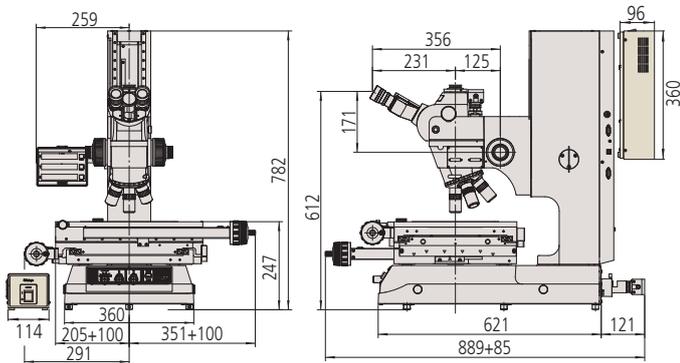
MF-UB1010D



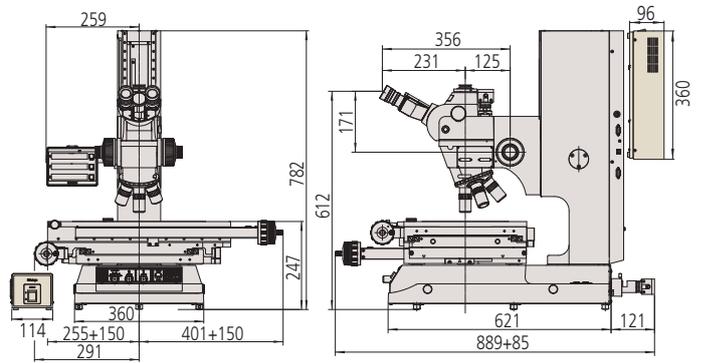
MF-UB2010D



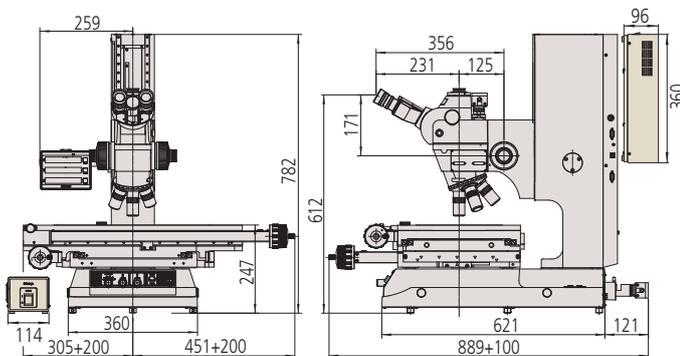
MF-UB2017D



MF-UB3017D



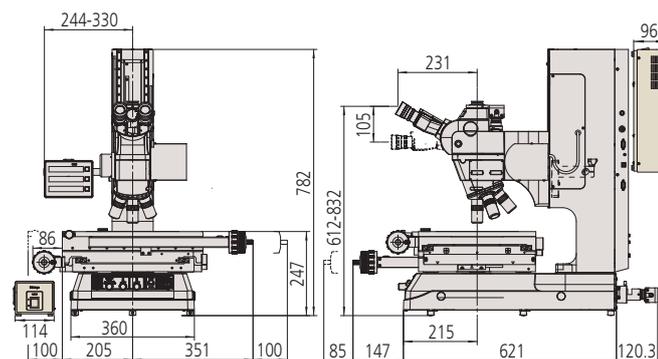
MF-UB4020D



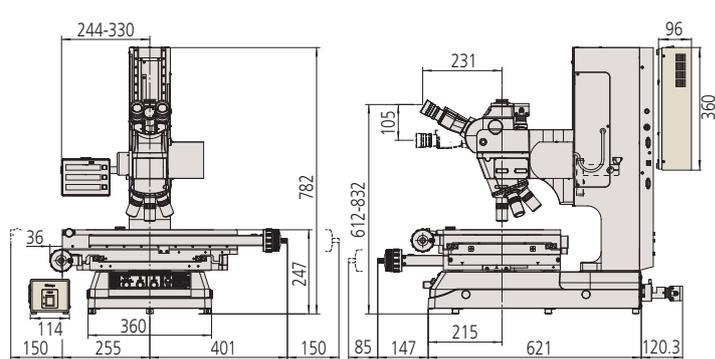
**Motor-Driven Z-axis Models** \* Common dimensions for MF-UJ and MF-UK models.

Unit: mm

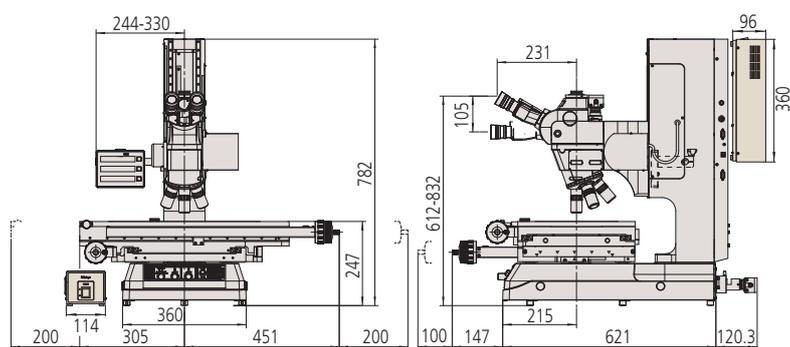
**MF-UJ2017D**



**MF-UJ3017D**



**MF-UJ4020D**

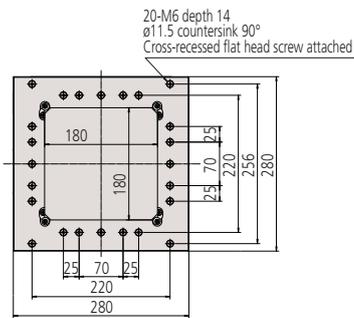


# Dimensions

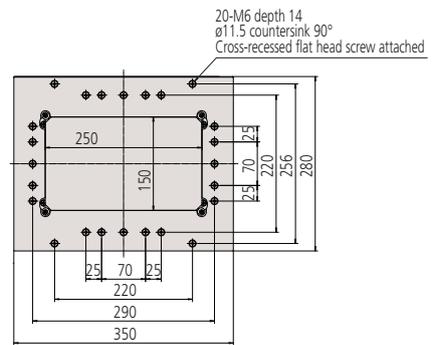
## Stage Top View \* Common dimensions for all models.

Unit: mm

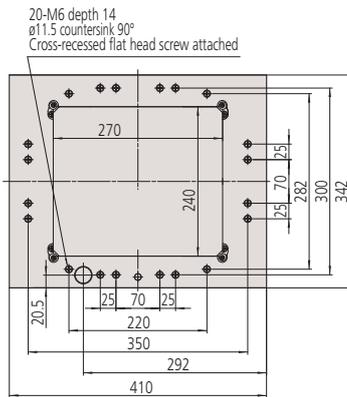
**Size 1010**  
100x100 mm



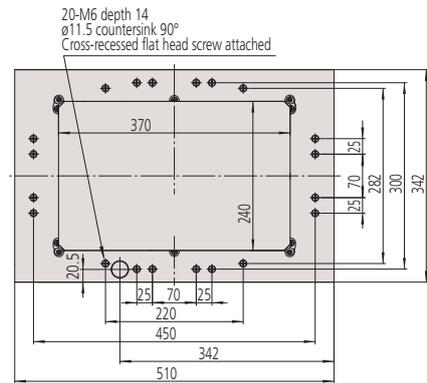
**Size 2010**  
200x100 mm



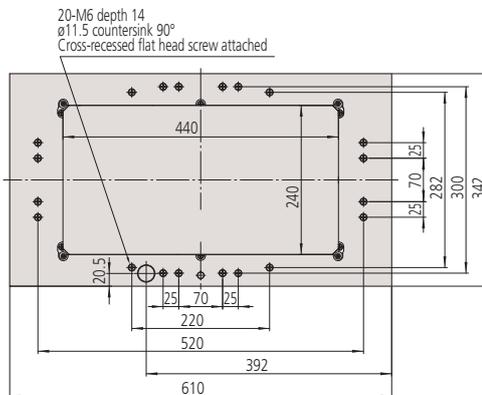
**Size 2017**  
200x170 mm



**Size 3017**  
300x170 mm



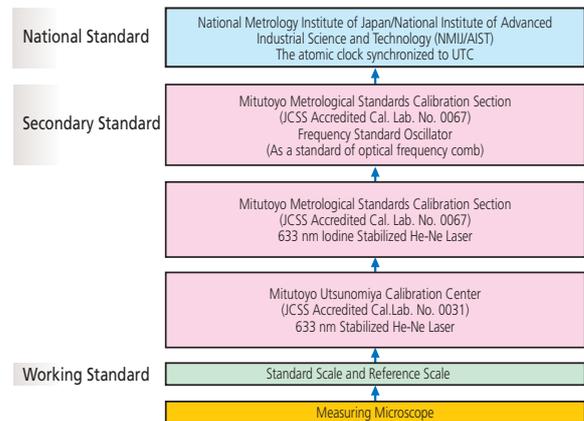
**Size 4020**  
400x200 mm



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### Traceability to National Standards

Mitutoyo ensures and maintains traceability of various types of precision measuring instruments by holding standards of length and other physical quantities that are directly traceable to the national standards for use in calibrating the working standards used for the calibration of measuring instrument products supplied to industry. Furthermore, Mitutoyo offers a temperature calibration service which is indispensable for high-accuracy length measurement.



Outline of the traceability chain for a Mitutoyo microscope.

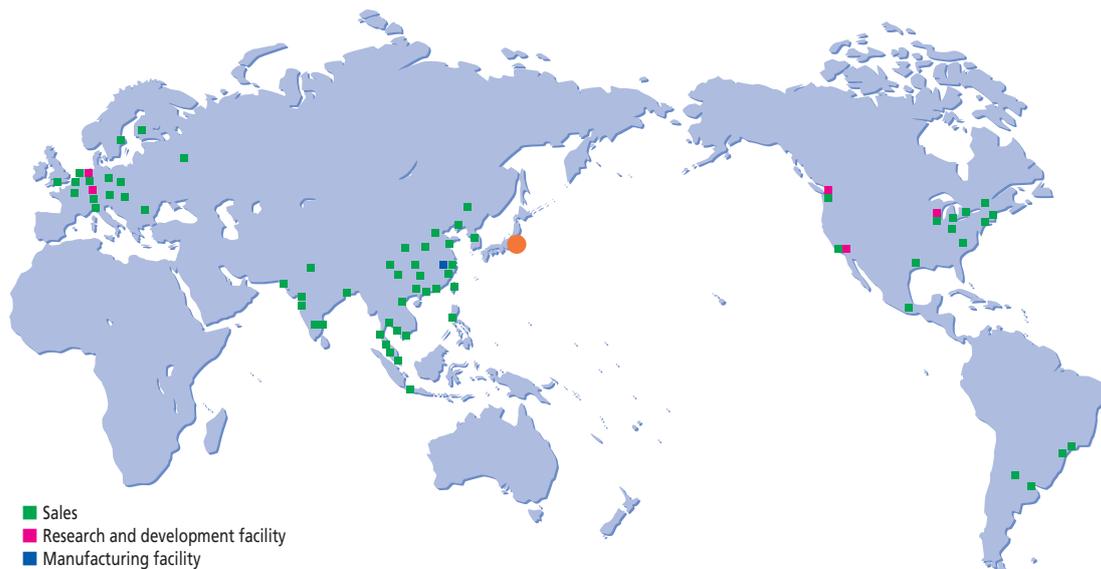
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- Sales
- Research and development facility
- Manufacturing facility



Mitutoyo Europe GmbH



Mitutoyo (UK) Ltd.



Mitutoyo France S.A.R.L.



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