TM-505B/1005B

SERIES 176 — Toolmakers' Microscopes

The Mitutoyo TM Series is a toolmakers' microscope well suited for measuring dimensions and angles of machined metals. It also can be used to check the shape of screws and gears by attaching an optional reticle. The compact body makes it ideal for use on shop floors with limited space.

FEATURES

- Angle measurement is performed easily by turning the angle scale disc to align the cross-hair reticle with the workpiece image.
- Illumination intensity can be adjusted.
- Included standard accessories create an overall magnification of 30X. Magnifications can be changed from 20 - 200X by using optional objectives and/or eyepieces.

TM-A505B

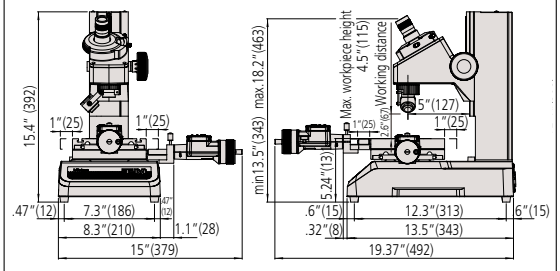
SPECIFICATIONS

Model No.		TM-505B	TM-A505B	TM-1005B	TM-A1005B
Order No.		176-818A	176-820A	176-819A	176-821A
Objective lens		Standard accessory: 2X, Options: 5X, 10X			
Microscope head	Maximum height of workpiece	4.53" / 115mm		4.21" / 107mm	
Illumination unit	Transmitted illumination	Stepless brightness adjustment, White LED light source, With green filter			
	Surface illumination	Oblique single-source type, Stepless brightness adjustment, White LED light source			
Cross-travel stage	Measuring range	2" x 2" / 50×50mm		4" x 2" / 100×50mm (An optional 2"/50mm gauge block is required to cover full range. A CERA block is recommended.)	
	Table size	16" x 6" / 52×152mm		9.44" x 6" / 240×152mm	
	Usable area of the stage glass	3.8" x 3.8" / 96×96mm		6" x 3.8" / 154×96mm	
Linear measurement method		Micrometer heads optional	Micrometer heads included	Micrometer heads optional	Micrometer heads included
Resolution		N/A	.00005"/1µm	N/A	.00005"/1µm
Micrometer head travel range		N/A	2"/50mm	N/A	2"/50mm

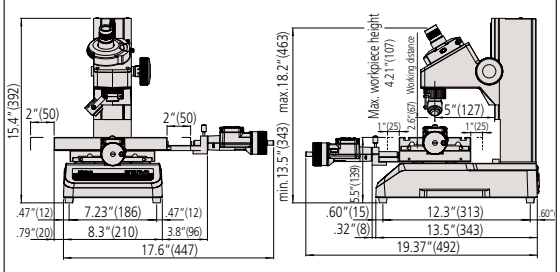
DIMENSIONS

Unit: Inch(mm)

TM-505B



TM-1005B



Technical Data

Optical tube	• Monocular with 30° depression angle • 90° broken cross-hair reticle (176-126) • Erect image • Diopter adjustable
Eyepiece protractor	• Graduation: 1° • Protractor range: 360° • Minimum reading by vernier: 6′
Eyepiece (176-116)	• Magnification: 15X • Field number: 13
Objective (176-138)	• Magnification: 2X • Working distance: 2.638" (67mm) • Numerical aperture: 0.07
Total magnification	• 30X
Transmitted illumination	• 3W LED • GIF (green) filter • Stepless intensity adjustment
Reflected illumination	• 3W LED • Stepless intensity adjustment • Adjustable position
Power supply	120 V AC, 50/60Hz
Power consumption	100VA
Mass	TM-505B: Approx. 30.8 lbs. (14kg) TM-1005B: Approx. 33 lbs. (15kg)

Optional Accessories

176-115: 10X eyepiece (view field dia.: 13mm)
176-116: 15X projection lens set (standard accessory)
176-117: 20X eyepiece (view field dia.: 10mm)
176-138: Objective, 2X (W.D. 67mm, N.A. 0.07) (standard accessory)
176-139: Objective, 5X (W.D.: 33mm, N.A.: 0.10)
176-137: Objective, 10X (W.D.: 14mm, N.A.: 0.14)
164-163: Digimatic micrometer head (range: 50mm, reading: 0.001mm)
164-164: Digimatic micrometer head (range: 2"/50mm, reading: .00005"/0.001mm)
152-390: Micrometer head for X-axis (range: 25mm, reading: 0.005mm)
152-389: Micrometer head for Y-axis (range: 25mm, reading: 0.005mm)
152-392: Micrometer head for Y-axis (range: 1", reading: .0001")
152-391: Micrometer head for X-axis (range: 1", reading: .0001")
611201-531: Rectangular gauge block (1")
611202-531: Rectangular gauge block (2")
176-204: Dial indicator attachment for Z-axis measurement
959149: SPC cable (2m) for Digimatic micrometer head
64PMI237: C-mount eyetube adapter

Fixture and Stage Accessories
990561: Workpiece clip (2pcs./set)
176-106: Rotary table for TM-505 (effective dia.: 66mm)
172-196: Rotary table for TM-510 (effective dia.: 100mm)
176-105: Swivel center support for TM-505 (max. workpiece dia.: 2.7" / 70mm)
172-197: Swivel center support for TM-510 (max. workpiece dia.: 3.1" / 80mm)
172-378: V-block with clamp (max. workpiece dia.: 1" / 25mm)
176-107: Holder with clamp

Illumination Units
176-344A: Bifurcated fiber illuminator
64AAB214: LED variable ring light
176-208A: LED circular illumination

Reticles
176-126: Broken cross-hair (90°) (standard accessory)
176-111: Concentric circles (up to ø4mm, 0.05mm increment)
176-135: Concentric circle (up to ø.2", .01" increment)
176-114: 60° angle
176-109: Metric screw threads (pitch = 0.25 - 1mm)
176-110: Metric screw threads (pitch = 1.25 - 2mm)
176-140: ISO metric screw threads (pitch = 0.075 - 0.7mm)
176-141: ISO metric screw threads (pitch = 0.75 - 2mm)
176-123: Unified screw threads (80 - 28TPI)
176-124: Unified screw threads (24 - 14TPI)
176-125: Unified screw threads (13 - 10TPI)
176-120: Whitworth screw threads (60 - 26TPI)
176-112: 20° involute gear teeth (normal rack type)

Protractor eyepiece

LED ring light 64AAB214

MF

SERIES 176 — Measuring Microscopes

The MF measuring microscopes can be combined with Mitutoyo's vision unit to boost its performance and data management on a PC, further improving measuring efficiency and productivity.

FEATURES

- Observation with a crisp and high-resolution erect image and a wide field of view
- Measuring accuracy that is highest in its class (and conforms to JIS B 7153)
- ML series, high-NA objectives that are specially designed for the MF series (long working distance type)
- Illumination unit (reflected/transmitted) selectable from a high-intensity LED or halogen bulb (selection required)
- Variable aperture diaphragm (reflected/transmitted) allows observation measurement while suppressing light diffraction
- Variety of standardized stages in sizes up to 400×200mm
- Quick-release mechanism useful for moving the stage quickly when measuring workpieces that are large in size or quantity
- Coarse/fine feed handles equipped as standard on both sides allow precise focus and observation measurement regardless of handedness
- High-magnification eyepiece observation up to 2000×
- Standard measuring microscope has a wide variety of optional accessories including a vision unit and various digital CCD cameras

MF-B2017D
XY stage travel range: 8 x 6.6″ / 200 x 170mm
(with optional binocular tube)

Using optional slide-type nosepiece with 2-lens mount (factory set option)

Technical Data

Optical tube	• Monocular or Binocular **(Must Choose)** • 25° depression angle • 90° broken cross-hair reticle (12AAG836) • Erect image • TV Mount 50/50
Observation image	• Erect Image
Observation type	• Bright Field
Eyepiece lens	• 10x (Included w/Tube) • 15x (Optional) • 20x (Optional)
Objective	• Magnification: 3X (Included) • W.D.: 3.03″ (77mm); N.A.: .09 • Optional: 1x, 5x, 10x, 20x, 50x, 100x
Light source	• Halogen or LED **(Must Choose)** • Adjustable aperture diaphragms • Light intensity infinitely adjustable
Transmitted illumination	• Telecentric illumination
Reflected illumination	• Koehler illumination
Display Unit	
Number of axis	• 2 axes (MF-A Type) or 3 axes (MF-B Type)
Resolution	• 0.0001″ / 0.00005″ / 0.00001″ (0.001 mm / 0.0005 mm / 0.0001 mm)
Functions	•Data output, Axis linear compensation, Metric or English Units, and more
Stage	• Precision travel (2.2+0.02L)µm accuracy • High-accuracy linear glass scales • Quick-release floating mode • Zero-set button
Power consumption	45W LED, 160W Halogen, 120V AC, 50/60 Hz
Mass	• 1010D - 148 lbs. / 67 kg • 2010D - 157 lbs. / 71 kg • 2017D - 326 lbs. / 148 kg • 3017D - 344 lbs./ 156 kg • 4020D - 357 lbs. / 162 kg

LED and Halogen Light Options for Transmitted and Reflected Illumination
(Common to MF D and MF-U D)

New design

Transmitted LED illumination unit (Common to MF/MF-U Series) | Reflected LED illumination unit (for MF Series) | Reflected LED illumination unit (for MF-U Series)

LED illumination | Halogen illumination

High Visibility Digital Display
(Common to MF D and MF-U D)

Front of display | Rear of display

Selection of XY stage by travel range

1010D: 4 x 4″ / 100 x 100mm

2010D: 8 x 4″ / 200 x 100mm

2017D: 8 x 6.7″ / 200 x 170mm

3017D: 12 x 6.6″ / 300 x 170mm

4020D: 16 x 8″ / 400 x 200mm

Mitutoyo

MF

SERIES 176 — Measuring Microscopes

SPECIFICATIONS

Model No. (XY stage size)		1010D	2010D	2017D	3017D	4020D
Order No.	MF-A	**176-861-10**	**176-862-10**	**176-863-10**	**176-864-10**	**176-865-10**
	MF-B	**176-866-10**	**176-867-10**	**176-868-10**	**176-869-10**	**176-870-10**
XY stage travel range		4 x 4" 100 x 100mm	8 x 4" 200 x 100mm	8 x 7" 200 x 170mm	12 x 7" 300 x 170mm	16 x 8" 400 x 200mm
Z-axis travel range		6" / 150mm		8.7" / 220mm		
Focusing method		Manual focusing (Coarse focusing: 30mm/rev., Fine focusing: 0.2mm/rev.)				
Measurement method		Linear encoder (2-axis model: X / Y-axis, 3-axis model: X / Y / Z-axis)				
Resolution (switchable)		.0001" / .00005" / .00001" (0.001mm / 0.0005mm / 0.0001mm)				
Measuring accuracy (at 20˚C)		XY-axis: (2.2+0.02L)µm, L = Measuring length (mm) when not loaded, JIS B 7153				
Indication accuracy (at 20˚C)		Z-axis: (5+0.04L)µm, L = Measuring length (mm), (MF-B type)				
Floating function		X and Y axes with Quick-release mechanism				
XY stage top size		11 x 11" 280 x 280mm	14 x 11" 350 x 280mm	16.1 x 13.4" 410 x 342mm	20.07 x 13.4" 510 x 342mm	24" x 13.4" 610 x 342mm
Effective glass size		7 x 7" 180 x 180mm	10 x 6" 250 x 150mm	10.6 x 9.4" 270 x 240mm	14.5 x 9.4" 370 x 240mm	17.3 x 9.4" 440 x 240mm
Swivel function		—		±5˚ (left)		±3˚ (left)
Max. stage loading		22lbs / 10kg		44lbs / 20kg		33lbs / 15kg
Max. workpiece height		6" / 150mm		8.7" / 220mm		

MF Selection of Machine Type

↓	1010	2010	2017	3017	4020	Counter	Motorized stage	Optics
A	**176-861-10**	**176-862-10**	**176-863-10**	**176-864-10**	**176-865-10**	X,Y	Manual	BF
B	**176-866-10**	**176-867-10**	**176-868-10**	**176-869-10**	**176-870-10**	X,Y,Z	Manual	BF
G	-	-	**176-781A**	**176-782A**	**176-783A**	X,Y,Z	X, Y, Z	BF
J	-	-	**176-891A**	**176-892A**	**176-893A**	X,Y,Z	Z only	BF

Example: MF-A1010D results in part number 176-861-10

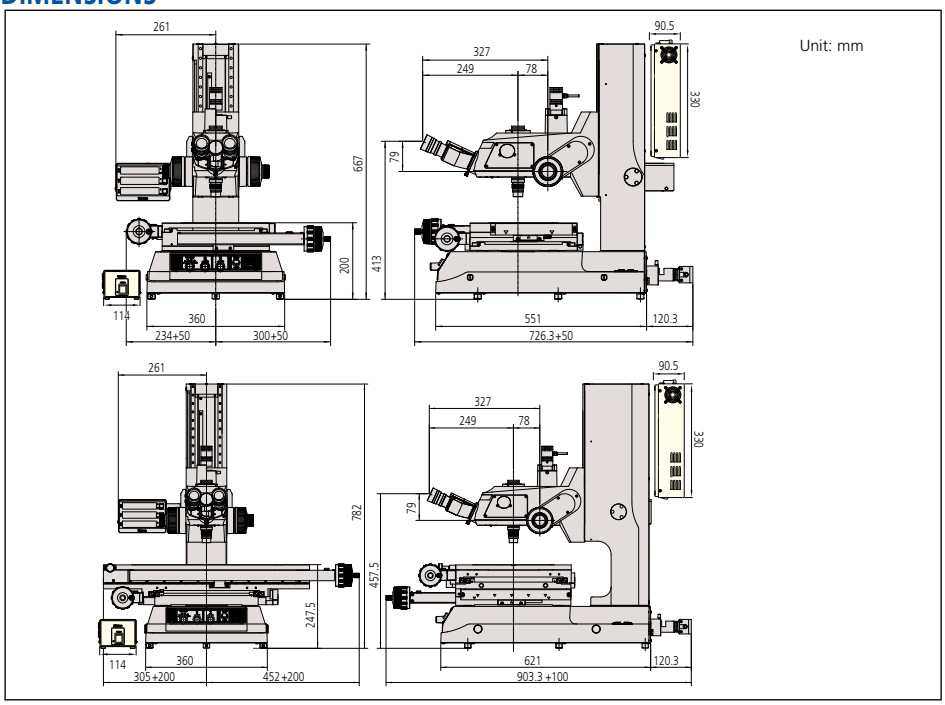
Illumination Unit (must select)

Applicable Illumination Unit	LED	Halogen
Order No.	**176-445A**	**176-447A**

Eye Tube Selection (must select)

Monocular with 10X eyepiece	**176-392**
Binocular with 10X eyepiece	**176-393**

DIMENSIONS



Optional Accessories

176-392: Monocular tube with 10X eyepiece
176-393: Binocular tube with 10X eyepiece set
378-866: 10X eyepiece set (view field dia.: 24mm)
378-857: 15X eyepiece set (view field dia.: 16mm)
378-858: 20X eyepiece set (view field dia.: 12mm)
375-043: Protractor eyepiece (10X)
176-313: Digital protractor eyepiece (10X)
375-036-2: 1X objective (W.D.: 61mm, N.A.: 0.03)
375-037-1: 3X objective (W.D.: 77mm, N.A.: 0.09) (std. accessory)
375-034-1: 5X objective (W.D.: 61mm, N.A.: 0.13)
375-039: 10X objective (W.D.: 51mm, N.A.: 0.21)
375-051: 20X objective (W.D.: 20mm, N.A.: 0.42)
375-052: 50X objective (W.D.: 13mm, N.A.: 0.55)
375-053: 100X objective (W.D.: 6mm, N.A.: 0.7)
176-370-1: Slide-type nosepiece (2-mount, parfocal)
176-370-2: Slide-type nosepiece (2-mount, mag. adjusted)
12AAA643: ND2 color filter (transmitted / surface)
12AAA644: ND8 color filter (transmitted / surface)
12AAA645: GIF filter (transmitted / surface) (std. accessory)
12AAA646: LB80 color filter (transmitted / surface)
375-054: 0.5X camera adapter (with C-mount adapter)
970441: C-mount adapter
513667: Halogen bulb (12V, 50W)
12BAB345: Halogen bulb (long life type, 12V, 50W)
176-308: Vibration damping stand
176-309: Mounting stand
375-056: Stage micrometer
12AAA165: Lens cleaning kit
12AAA846: Foot switch
382951: Vinyl cover (standard accessory) 2010 or less
12BAM841: Vinyl cover 2017 or greater

Illumination Units
176-367-2A: LED ring illuminator
176-343A: Twin fiber-optics illuminator
176-366A: Ring fiber-optics illuminator
12AAG806: GIF color filter (for fiber-optics illuminator)
12AAG807: LB80 color filter (for fiber-optics illuminator)

Fixture and Stage Accessories
176-107: Holder with clamp
172-378: V-block with clamp
(max. workpiece dia.: 1" / 25mm)
172-197: Swivel center support[1]
(max. workpiece dia.: 3.1" / 80mm)
176-305: Rotary stage with fine feed knob for 1010D/2010D models
176-306: Rotary stage with fine feed knob for 2017D/3017D/4020D models

[1] Fixture mount adapter (**176-310**) is required for 2010D models.
Fixture mount adapter (**176-304**) is required for 2017D/3017D/4020D models.

QM-Data200
2-D data processing unit
264-155A: Stand-mount type
12AAA807: Connecting cable set

Focus pilot FP-05
Focus assisting system

Vision Unit
PC-based vision measuring system
359-763

MF Motorized

SERIES 176 — Motorized Type Measuring Microscopes

- Motorized model of the MF Series. The X-, Y- and Z-axes are motorized, and the stage can be operated using a remote box.
- Using the optional vision unit enables the image AF function.
- Illumination unit (reflected/transmitted) can be selected from a high-intensity LED or halogen bulb (selection required).
- Variable aperture diaphragm (reflected/transmitted) allows observation measurement while suppressing light diffraction.
- A wide variety of optional accessories are offered.
- ML series, high-NA objectives that are specially designed for the MF series (long-working distance type).
- High-magnification observation up to 2000X.

MF-G2017D
- The binocular tube (eyepiece) and illumination unit are optional accessories.

SPECIFICATIONS

	Model No.	MF-G2017D	MF-G3017D	MF-G4020D
	Order No.	**176-781A**	**176-782A**	**176-783A**
Observation image		BF (Bright field)/Erect image		
Eyepiece	Diopter adjustment	10X (field number: 24), 15X, 20X Note: Monocular unit: a 10X eyepiece (standard accessory), Binocular tube: two 10X eyepieces (standard accessory)		
Objective lens		ML series 3X objective lens (standard accessory), 1X, 5X, 10X, 20X, 50X, 100X		
Illumination unit (One of the two options must be selected.)	LED illumination unit	Transmitted illumination: Telecentric system, Built-in aperture diaphragm, White LED light source, stepless light intensity control, with cooling fan Reflected illumination: Koehler illumination, Variable aperture diaphragm mechanism, White LED light source, stepless light intensity control Control unit: Power ON/OFF switch (main switch), 100 - 240V AC power input connector		
	Halogen illumination unit	Transmitted illumination: Telecentric system, Built-in aperture diaphragm, Halogen bulb (12V, 50W), stepless light intensity control, with cooling fan Reflected illumination: Koehler illumination, Variable aperture diaphragm mechanism, Halogen bulb (12V, 50W), stepless light intensity control, with cooling fan Control unit: Power ON/OFF switch (main switch), 100 - 240V AC power input connector		
Vision AF *1		Available Option		
XY-axis Vision	Measuring range	200×170mm	300×170mm	400×200mm
Z-axis	Measuring range	220mm		
Measuring accuracy *2	(When no load is put on the X- or Y-axis)	(2.2+0.02L) µm L: Measuring length (mm)		
Digital counter	Resolution	1/0.5/0.1µm .0001"/.00005"/.00001" switchable		

*1: Vision Unit **359-763** and an image AF cable **12AAN358** are sold separately.
*2: Measuring method complies with JIS B7153.

Bulb replacement for transmitted/reflected illumination Standard: Halogen bulb (12V, 50W) (**No.513667**)
Bulb life: 1,100 hours

Mitutoyo

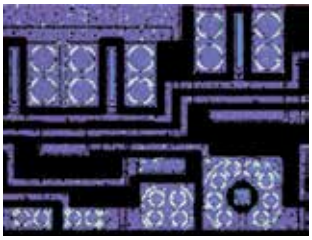
MF-U

SERIES 176 — High-power Multi-function Measuring Microscopes

FEATURES

- Observation with a clear and flareless erect image and a wide field of view
- Measuring accuracy that is highest in its class (and conforms to JIS B 7153)
- Proven high-NA objectives from the FS optical system (long-working distance type)
- Integration of metallurgical and measurement microscope functions provides high-resolution observation and high-accuracy measurement solution
- Illumination unit (reflected/transmitted) selectable from a high-intensity LED or halogen bulb (required)
- Variable aperture diaphragm (reflected/transmitted) allows for contrast adjustment
- Variety of standardized stages in sizes up to 400 × 200 mm
- Quick-release mechanism useful for moving the stage quickly when measuring workpieces that are large in size or quantity
- High-magnification eyepiece observation up to 4000X

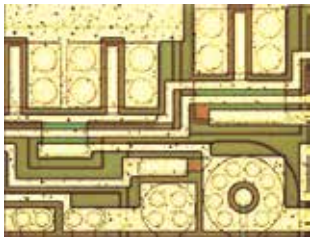
MF-UB3017D
XY stage travel range: 12 x 6.7″ / 300 x 170mm
(with optional turret, objective and fiber illumination)



Polarized light observation:
Observing only the filtered light that vibrates in one direction. Used for observing materials with special optical characteristics, such as mineral and liquid crystal.

Differential interference contrast (DIC) observation:
Effective in detecting fine scratches and steps on the surface of metal, liquid crystal, and semiconductors.

Dark field (DF) observation:
Observing only the scattered light by shutting down the direct light to the objectives. The scratches and dust that cannot be viewed in the bright view field can be observed by this method in high-contrast.



Bright field (BF) observation:
Most common method of observation. Observing directly the light reflected from the surface of the workpiece.

Technical Data

Observation image:	Erect image
Optical tube:	Siedentoph type (pupil distance adjustment: 51 - 76mm), 1X tube lens, Binocular tube (depression: 30˚), Reticle projection method, with TV mount, Optical path ratio (eyepiece/TV mount: 50/50)
Eyepiece lens:	10X (field No.: 24mm), Optional: 15X, 20X
Turret (optional):	Manual or power
Objective (optional):	M / BD Plan Apo objective from 1X to 200X
Transmitted illumination	
• Light source:	Halogen bulb (12V, 50W) or LED
• Optical system:	Telecentric illumination with adjustable aperture diaphragms
• Functions:	Light intensity adjustable, Non-stepped brightness adjustment
Surface illumination	
• Light source:	Optional halogen illumination unit (fiber-optic cold light illumination) or LED
• Optical system:	Koehler illumination with adjustable aperture diaphragms
• Functions:	Light intensity adjustable, Non-stepped brightness adjustment
Display unit:	
• No. of axis:	2 axes or 3 axes
• Resolution:	.0001″ / .00005″ / .00001″ / 0.001mm / 0.0005mm / 0.0001mm
• Functions:	Zero-setting, Direction switching, Data output (via RS-232C interface)
Power supply:	120V AC, 50/60Hz
Mass:	148lbs/67kg (1010D) / 157lbs/71kg (2010D) / 326lbs/148kg (2017D) / 344lbs/156kg (3017D) / 357lbs/162kg (4020D)

Selection of XY stage by travel range

1010D: 4 x 4″ / 100 x 100mm

2010D: 8 x 4″ / 200 x 100mm

2017D: 8 x 6.7″ / 200 x 170mm

4020D: 16″ x 8″ / 400 x 200mm

MF-U

SERIES 176 — High-Power Multi-Function Measuring Microscopes

SPECIFICATIONS

Model No. (XY stage size)		1010D	2010D	2017D	3017D	4020D
Order No.	MF-UA	**176-871-10**	**176-872-10**	**176-873-10**	**176-874-10**	**176-875-10**
	MF-UB	**176-876-10**	**176-877-10**	**176-878-10**	**176-879-10**	**176-880-10**
	MF-UC	**176-881-10**	**176-882-10**	**176-883-10**	**176-884-10**	**176-885-10**
	MF-UD	**176-886-10**	**176-887-10**	**176-888-10**	**176-889-10**	**176-890-10**
XY stage travel range		4 x 4" 100 x 100mm	8 x 4" 200 x 100mm	8 x 6.7" 200 x 170mm	12 x 6.7" 300 x 170mm	16 x 8" 400 x 200mm
Z-axis travel range		6" / 150mm		8.7" / 220mm		
Focusing method		Manual focusing (coarse focusing: 10mm/rev., fine focusing: 0.1mm/rev.)				
Measurement method		Linear encoder (2-axis model: X / Y-axis, 3-axis model: X / Y / Z-axis)				
Resolution (switchable)		.0001" / .00005" / .00001" (0.001mm / 0.0005mm / 0.0001mm)				
Measuring accuracy (at 20˚C)		XY-axis: (2.2+0.02L)μm, L = Measuring length (mm) when not loaded, JIS B 7153				
Indication accuracy (at 20˚C)		Z-axis: (5+0.04L)μm, L = Measuring length (mm)				
Floating function		X and Y axes with Quick-release mechanism				
XY stage top size		11 x 11" 280 x 280mm	14 x 11" 350 x 280mm	16 x 13.6" 410 x 342mm	20 x 13.6" 510 x 342mm	24 x 13.6" 610 x 342mm
Effective glass size		7.1 x 7.1" 180 x 180mm	10 x 6" 250 x 150mm	10.6 x 9.6" 270 x 240mm	14.6 x 9.6" 370 x 240mm	17.3 x 9.6" 440 x 240mm
Swivel function		—		±5˚ (left)		±3˚ (left)
Max. stage loading		22lbs / 10kg		44lbs / 20kg		33lbs / 15kg

Selection of machine type

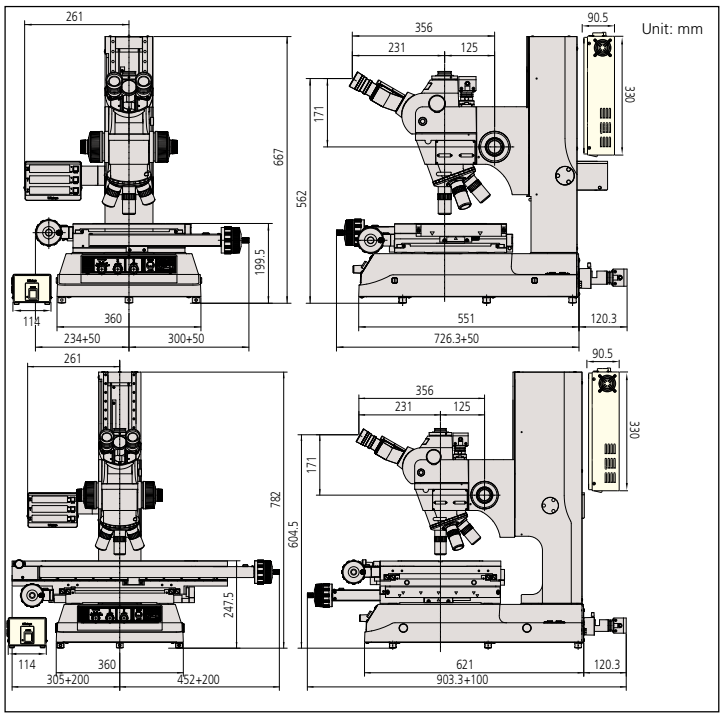
Machine type	MF-UA	MF-UB	MF-UC	MF-UD
Observation type	Bright field (BF)	Bright field (BF)	Bright / Dark field (BF/DF)	Bright / Dark field (BF/DF)
Measurement system	X and Y-axis (2 axes)	X, Y and Z-axis (3 axes)	X and Y-axis (2 axes)	X, Y and Z-axis (3 axes)

Illumination Unit (must select LED or Halogen illumination unit)

Applicable Illumination Unit	LED	Halogen
Order No.	**176-446A** (transmitted & reflected)	**176-448A** (transmitted)
		176-316A (reflected)

Note: illumination unit not included. If halogen transmitted illumination is selected, then either 176-315A or 176-316A must be chosen.

DIMENSIONS



Optional Accessories

378-866: 10X eyepiece set (view field dia.: 24mm) (standard accessory)
378-857: 15X eyepiece set (view field dia.: 16mm)
378-858: 20X eyepiece set (view field dia.: 12mm)

Turret (Nosepiece) **must select**
378-018: Adjustable manual BF turret (4 port)
378-216A: Adjustable power BF turret (5 port)
176-211: Adjustable manual BF/DF turret (4 port)
176-212A: Adjustable power BF/DF turret (4 port)

Objectives
See page I-28 for objective selection

Manual and Power Turrets

Filters
378-092: Polarization unit
378-076: DIC unit for 100X, SL80X, SL50X objective
378-078: DIC unit for 50X, SL20X objective
378-079: DIC unit for 20X objective
378-080: DIC unit for 10X, 5X objective
12AAA643: ND2 color filter (for halogen illuminator, **176-448A**)
12AAA644: ND8 color filter (for halogen illuminator, **176-448A**)
12AAA645: GIF filter (standard accessory)
12AAA646: LB80 color filter (for halogen illuminator, (**176-448A**)

Camera Mounts
375-054: 0.5X camera adapter (with C-mount adapter)
970441: C-mount adapter
See page I-33 for camera selection

Bulbs
513667: Halogen bulb (12V, 50W)
12BAB345: Halogen bulb (long life type, 12V, 50W)
517181: Halogen bulb (12V, 100W)
12BAD602: High intensity halogen bulb (12V, 100W)

Illumination Units
176-315A: Halogen illumination unit (12V, 100W)
176-316A: Halogen illumination unit (12V, 150W)
176-343A: Twin fiber-optics illuminator
12AAG806: GIF color filter (for **176-315A** and **176-343A**)
12AAG807: LB80 color filter (for **176-315A** and **176-343A**)

Fixture and Stage Accessories
176-107: Holder with clamp
172-378: V-block with clamp (max. workpiece dia.: 1" / 25mm)
172-197: Swivel center support* (max. workpiece dia.: 3.1" / 80mm)
176-305: Rotary stage with fine feed knob for 1010D/2010D models
176-306: Rotary stage with fine feed knob for 2017D/3017D models
*Fixture mount adapter (**176-310**) is required for 2010D models.
Fixture mount adapter (**176-304**) is required for 2017D/3017D/4020D models.

Misc.
176-308: Vibration damping stand
176-309: Mounting stand
375-056: Stage micrometer
12AAA165: Lens cleaning kit
937179T: Foot switch
Reticle See page I-21

Mitutoyo

MF-U Motorized

SERIES 176 — Motorized-Type Universal Measuring Microscopes

- Motorized model of the MF-U Series. The X-, Y- and Z-axes are motorized, and the stage can be operated using a remote box.
- Using the optional vision unit enables the image AF function.
- Illumination unit (reflected/transmitted) can be selected from a high-intensity LED or halogen bulb (required).
- Variable aperture diaphragm (reflected/transmitted) allows observation measurement while suppressing light diffraction.
- A wide variety of optional accessories are offered.
- Proven high-NA objectives from the FS optical system (long working distance type).
- Integration of metallurgical and measurement microscope functions provide high-resolution observation and a high-accuracy measurement solution.
- High-magnification observation up to 4000X.
- MF-UE/UF is capable of performing Laser AF. The standard Laser AF function is equipped with the tracking function which maintains focus while the stage is in motion.

MF-UE2017D
- The turret, objectives and illumination unit are sold separately.

MF-U Selection of Machine Type

↓	2017	3017	4020	Counter	Motorized stage	Optics	LAF	Vision Unit
E	176-790A	176-791A	176-792A	X,Y,Z	X, Y, Z	BF	✓	✓
F	176-793A	176-794A	176-795A	X,Y,Z	X, Y, Z	BF/DF	✓	✓
G	176-784A	176-785A	176-786A	X,Y,Z	X, Y, Z	BF	-	✓
H	176-787A	176-788A	176-789A	X,Y,Z	X, Y, Z	BF/DF	-	✓
J	176-894A	176-895A	176-896A	X,Y,Z	Z only	BF	-	✓
K	176-897A	176-898A	176-899A	X,Y,Z	Z only	BF/DF	-	✓

Example: MF-UE2017D results in part number 176-790A

SPECIFICATIONS

BF (Bright field)	Model No.	MF-UG2017D	MF-UG3017D	MF-UG4020D	MF-UE2017D	MF-UE3017D	MF-UE4020D
	Order No.	176-784A	176-785A	176-786A	176-790A	176-791A	176-792A
BD (Bright / Dark field)	Model No.	MF-UH2017D	MF-UH3017D	MF-UH4020D	MF-UF2017D	MF-UF3017D	MF-UF4020D
	Order No.	176-787A	176-788A	176-789A	176-793A	176-794A	176-795A
Observation image		BF (Bright field), DF (Dark field) (MF-UC and MF-UD models only), Polarization, Differential Interference Contrast (DIC) / Erect image					
Eyepiece	Diopter adjustment	10X (standard accessory) (Field number: 24), 15X, 20X					
Objective lens (optional)	BF (Bright field)	M Plan Apo, M Plan Apo HR, M Plan Apo SL, G Plan Apo					
	BD (Bright / Dark field)	BD Plan Apo, D Plan Apo HR, BD plan Apo SL					
Illumination unit (One of the two options must be selected.)	LED illumination unit	Transmitted illumination: Telecentric system, Built-in aperture diaphragm, White LED light source, stepless light intensity control, with cooling fan Reflected illumination: Koehler illumination, Variable aperture diaphragm mechanism, White LED light source, Non-step light intensity control Control unit: Power ON/OFF switch (main switch), 100 - 240V AC power input connector					
	Halogen illumination unit	Transmitted illumination: Telecentric system, Built-in aperture diaphragm, Halogen bulb (12V, 50W), stepless light intensity control, with cooling fan Reflected: BF/BD Kohler illumination with adjustable aperture diaphragm, 12V100W or 12V15W halogen lamp (selectable), external fiber illumination, stepless brightness adjustment Control unit: Power ON/OFF switch (main switch), 100 - 240V AC power input connector					
Vision AF *1		✓			✓		
Laser AF *1		—			✓		
XY-axis	Measuring range	8×6.7" / 200×170mm	12×6.7" / 300×170mm	16×8" / 400×200mm	8×6.7" / 200×170mm	12×6.7" / 300×170mm	16×8" / 400×200mm
Z-axis	Measuring range	8.7" / 220mm					
Measuring accuracy	(When no load is put on the X- or Y-axis)	(2.2+0.02L) μm L: Measuring length (mm)					
Digital counter	Resolution	1/0.5/0.1μm .0001"/.00005"/.00001" switchable					

*1: Vision unit and an image AF cable are separately required.
*2: Measuring method complies with JIS B7153.

Bulb replacement for transmitted illumination Standard: Halogen bulb (12V, 50W) **(No.513667)**, Bulb life: 1,100 hours
For replacement for reflected illumination (from separate light source) Standard: Halogen bulb (12V, 100W) **(No.517181)**,
High-intensity bulb (12V, 100W) **(No.12BAD602)**
*At the time of purchase, a standard bulb and a high-intensity bulb are provided. (Only for the reflected illumination models.)

Accessories for Measuring Microscope

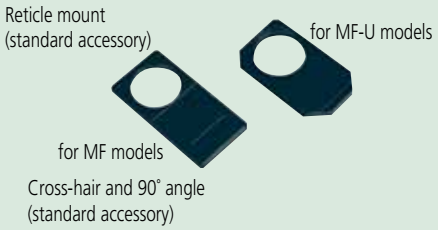
Stage Micrometer

SPECIFICATIONS

Order No.	375-056
Range	1mm
Graduations	0.01mm
Accuracy (at 20˚C)	(1+L)µm, L = Measuring length (mm)
Dimensions (WxD)	3" x 1" / 76 x 26mm
Mass	16g

Optional Reticles

12AAG838 (12AAG878): Cross-hair (7µm width)
12AAG836 (12AAG877)*: Cross-hair (5µm width)
12AAG873 (12AAG876): Cross-hair (3µm width)
12AAG839 (12AAG879): Cross-hair and 45˚ angle
12AAG840 (12AAG880): Broken cross-hair and 60˚ angle
12AAG841 (12AAG881): Zeiss type chart
12AAG842: 20mm scale (0.1mm reading)
12AAG843: Concentric circle (ø1.2 - ø18mm)
12AAG844: 10mm scale (0.1mm reading)
12AAG845: 5mm scale (0.05mm reading)
12AAG846: 10x10mm section (1mm min.)
12AAG847: Metric screw thread (P = 0.25-1.0)
12AAG848: Metric screw thread (P = 1.25-2.0)
12AAG849: Involute gear tooth (14.5˚), module = 0.1 - 1.0
12AAG850: Involute gear tooth (20˚), module = 0.1 - 1.0
12AAG851: Unified screw thread (80 - 28TPI)
12AAG852: Unified screw thread (24 - 14TPI)
12AAG853: Unified screw thread (13 - 10TPI)
12AAG854: Concentric circle (ø.01" - ø.2")
( ): for MF-U models,
* Standard accessory



Focus Pilot FP-05

FEATURES

- By installing this system on the camera mount of an MF series measuring microscope and projecting the focusing chart onto the workpiece surface, the focal point can be detected with high accuracy and high repeatability.
- The brightness of the chart can be adjusted.
- A wide view field observation on the monitor is made possible with the use of a CCD camera (C-mount adapter is included.)
- Four types of chart patterns are available. The pattern should be selected in accordance with the type of workpiece surface texture.

Concentric circle

Slit

SPECIFICATIONS

Order No.	375-057A	375-058A	375-067A	375-068A
Applicable microscopes	MF D models		MF-U D models	
Light source	Green LED	Red LED	Green LED	Red LED
Magnification	0.5X, Accuracy: 0.1%**			
Camera adapter	C-mount (provided)			
Applicable CCD camera	Up to 2/3-inch			
Mass	4lbs / 1.8kg			

** Within 2/3 area from the center of view field

Manual and Power Turrets

SPECIFICATIONS

Order No.	176-211	378-018	176-212A	378-016A	378-216A
Observation type	BD	BF	BD	BF	BF
No. of objective mounts	4-mount	4-mount	4-mount	4-mount	5-mount
Driving method	Manual		Motor		
Dimensions (W x D x H)	—	—	Turret: 6.5 x 2.6 x 5.4" 164 x 65 x 137		
			Control Box: 4.1 x 3 x 7.6" 108 x 72 x 193		

Accessories for Measuring Microscope

Twin fiber-optics illuminator

SPECIFICATIONS

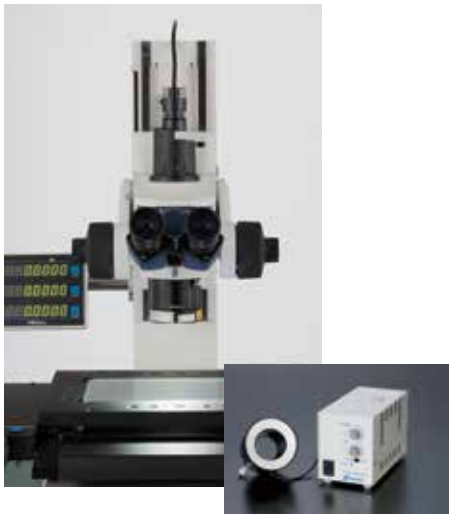
Order No.	176-343A
Applicable microscopes	MF, MF-U models
Length of fiber cable	28" / 700mm
Light source	Halogen bulb (12V, 100W) (**517181**: halogen bulb)
Dimensions (W x D x H)	Light unit: 9.3 x 3 x 4.7" 235 x 76 x 120mm

Ring fiber-optics illuminator

SPECIFICATIONS

Order No.	176-366A
Applicable microscopes	MF models (ML 10X or lower)
Length of fiber cable	40" x 1000mm
Light source	Halogen bulb (12V, 100W) (**517181**: halogen bulb)
Dimensions (W x D x H)	Light unit: 9.3 x 3 x 4.7" 235 x 76 x 120mm

LED Ring Illuminator



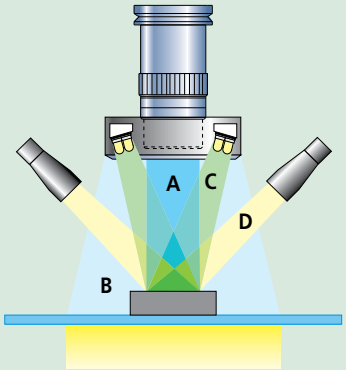
SPECIFICATIONS

Order No.	176-367-2A
Applicable microscopes	MF models with 1X/3X/5X/10X objective
Light source	White LED
Length of LED cable	59" / 1500mm

LED Ring Light (for sliding nosepiece)

SPECIFICATIONS

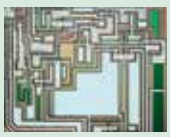
Order No.	176-371A
Applicable microscopes	MF models with 1X/3X/5X/10X objective
Light source	LED



A: Vertical surface illumination (Halogen)


PCB


HDD suspension


IC circuit

B: Ring fiber optics illumination


Flexible PCB


PCB


Electric parts

C: LED ring illumination


HDD suspension


PCB


Black resin molded parts

D: Twin fiber-optics illumination

IC package


Garnet


PCB

QM-Data200

SERIES 264 — 2-D Data Processing Unit

Technical Data

Resolution:	0.0001mm
Program functions:	Part program creation, execution, editing
Statisical processing:	Number of data, maximum value, minimum value, mean value, standard deviation, range, histogram
Element memory:	Maximum of 1000 elements
Element recall:	Point, line, circle, distance, ellipse, rectangular hole, slotted hole, intersection and intersecting angle
Element key-in:	Point, line, circle
Display system:	Monographic LCD (320 x 240 dots, with back light)
Measurement result file output:	RS-232C/USB output (CSV format, MUX-10F format)
Display language:	Japanese/English/German/French/ Italian/Spanish/Portuguese/Swedish/ Polish/Dutch/Hungarian
Data input:	RS-232C/USB, X/Y/Z-axis signal, Footswitch
Data output:	RS-232C/USB
Power supply	120V AC, 50/60Hz
Mass	2.2kg (stand-mount type) 2.1kg (arm-mount type)

QM-Data200
Order No.: 264-155A (stand-mount type)
Order No.: 264-156A (arm-mount type)

The QM-Data200 is a geometric readout/ analysis unit for optical instruments like profile projectors. This features powerful 2-D coordinate measurement capabilities with unmatched simple key operation. The QM-Data200 improves operator productivity, minimizes errors, and saves measurement time and production cost.

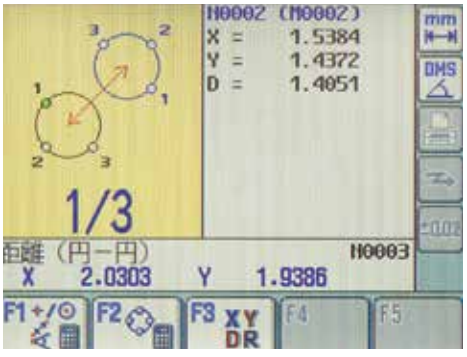
FEATURES

- Various graphic displays on the large colored LCD screen for easy measurement operations.
- One-key operation for combined measurements that are often used (circle-circle distance, etc.)
- The AI measurement function (automatic identification of measuring item) eliminates switching between the measurement command keys.
- Equipped with the measurement procedure teaching function and the measuring position navigation in Repeat mode.
- The user menu function allows user to register measurement commands or part programs to create his own menu.
- Tolerance zone measurement of data processing result and various statistical processing for each item is available.
- Measurement result output to "MS-Excel" in spreadsheet (CSV) format.
- The measurement procedure and measurement result can be saved, using a USB drive.
- Two models available: a stand-alone type with tilt system and a flexible-arm type that can be mounted on a profile projector.

QM-Data 200
Stand-mount type

• Intuitive panel design
The QM-Data200 employs Geometry Keys to accelerate the measurement process. The probing routine of standard geometric features and combinations are designed with Geometry Keys on the front panel. Click the key you need and capture features to complete the measurement quickly and accurately. This improves operator productivity, reduce errors, and saves operation time and cost.

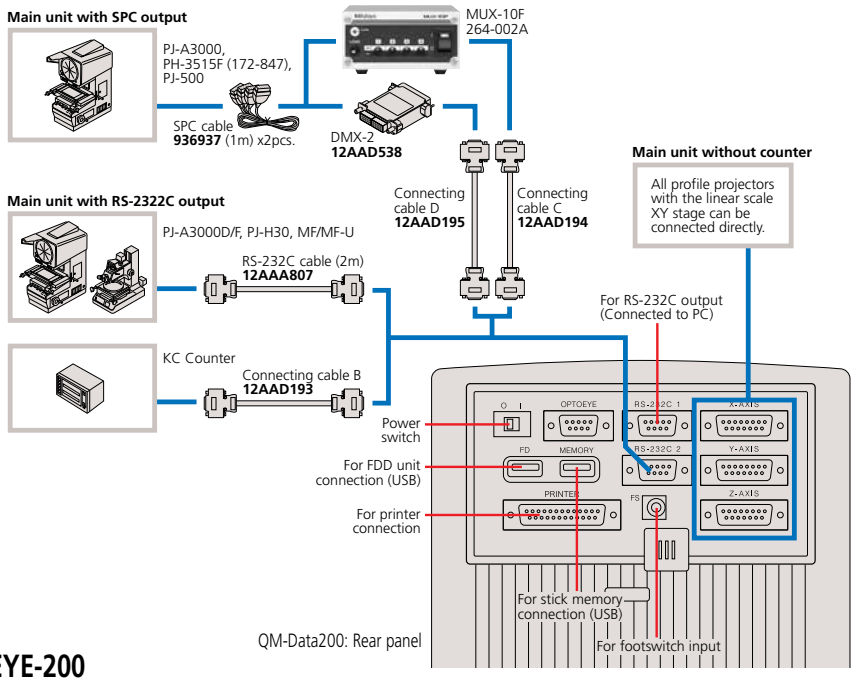
• Graphic display
Measurement information and data are visualized on the back-lit colored LCD with graphical interfaces. The geometric feature selected is displayed with the probing navigator. The measurements map and blink indication show the probing points and sequences. This improves operation accuracy and reduces errors and time.



QM-Data200

SERIES 264 — 2-D Data Processing Unit

SYSTEM DIAGRAM



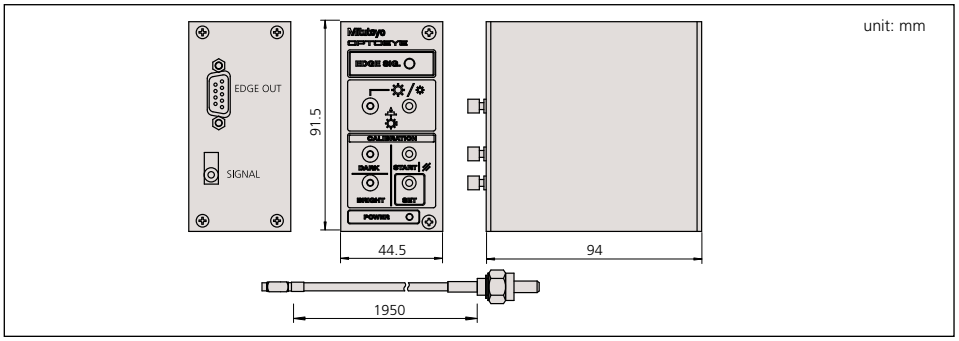
OPTOEYE-200

The OPTOEYE-200 Image Edge Sensor eliminates human errors, ensuring speedy, accurate and consistent measurements, regardless of operator's skill.

FEATURES

- OPTOEYE-200 adopts a thin fiber-optic cable for detector connection for easy set-up and smart operation without obstructing your view.
- Bright and dark buttons allow easy calibration.
- OPTOEYE can be powered by QM-Data200 via the connecting cable. No AC adapter is required.
- The brightness of the chart can be adjusted.

DIMENSIONS



Optional Accessories

12AAD034: Receipt printer (for 120V)
223663: Printer paper for receipt printer
12AAA804: Printer cable (2m)
937179T: Foot switch
12AAD193: Connection cable B
12AAD194: Connection cable C
12AAD195: Connection cable D
12AAA807: RS-232C cable (2m)
12AAA808: RS-232C cable (4m)

Technical Data

Image detection
- Directivity: Non-direction
- Min. diameter: ø2mm on the screen
- Min. width: 1mm on the screen
- Max. moving speed: 1000mm/s

Applicable illumination
- Type: Surface / Contour illumination
- Range: 30Lx to 1500Lx on the screen
  Bright-Dark field difference: 20Lx

Repeatability: 1µm in contour illumination
Function: Error in detection of illumination change
Supporting a contour illumination
brightness selector switch of projector

Optional Accessories

12AAE671:
Detector attachment (A)
PJ-A3000, PJ-H30, PH-3515, PH-A14 series
(Adaptation diameter of a screen:
10" / ø250 to 14" / ø350mm)

12AAE672:
Detector attachment (B)
PJ-500, PV-5110, PV-600A series
(Adaptation diameter of a screen:
20" / ø500 to 24" / ø600mm)

Vision Unit

SERIES 359 — Vision System Retrofit for Microscopes

SPECIFICATIONS

Projected Image	Inverted Image
Onscreen Magnification	19x-1900x (22" Monitor)
Camera Unit	
Image Sensor Size	1/2" Color CMMOS
Image Sensor Resolution	3 MP
Interface	USB 2.0
Dimensions (WxDxH)	2.28 x 2.32 x 3.27" 58 x 59 x 83mm
Adapter Unit	
Measurement Software	QSPak VUE (optional)
Dimensions (DXH)	1.77 x 4.84" / 45 x 123mm
Magnification	0.5x
Optional Accessory:	Foot Switch **(12AAJ088)**

QSPAK, optional software

For observation/comparison of form

- Template matching function
- Manual pattern matching function

For simple measurement

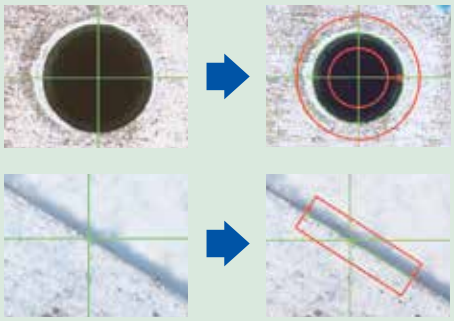
- One-click edge detection tool function
- Smart tool function
- User macro function

For repeated measurement/ auto-measurement

- Quick navigation function
- Playback function
- Graphic function
- External data output function
- Statistical calculation function

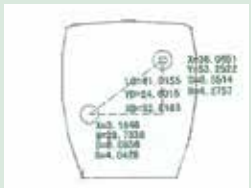
One-click Edge Detection

By clicking the mouse near the edge of a workpiece, QSPAK automatically scans the edge and detects it, showing its coordinates. This function also works with the point tool, box tool, circle tool and auto-focus tool.



Graphic Window

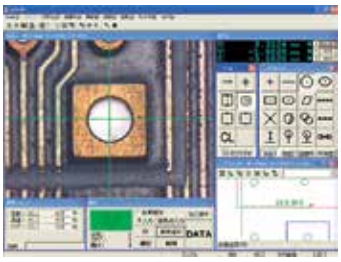
The measurement results and measured elements are plotted in the graphic window in real-time. By using this function, the user can check the current measuring position at a glance. The graphic window can be used for geometrical calculation.



FEATURES

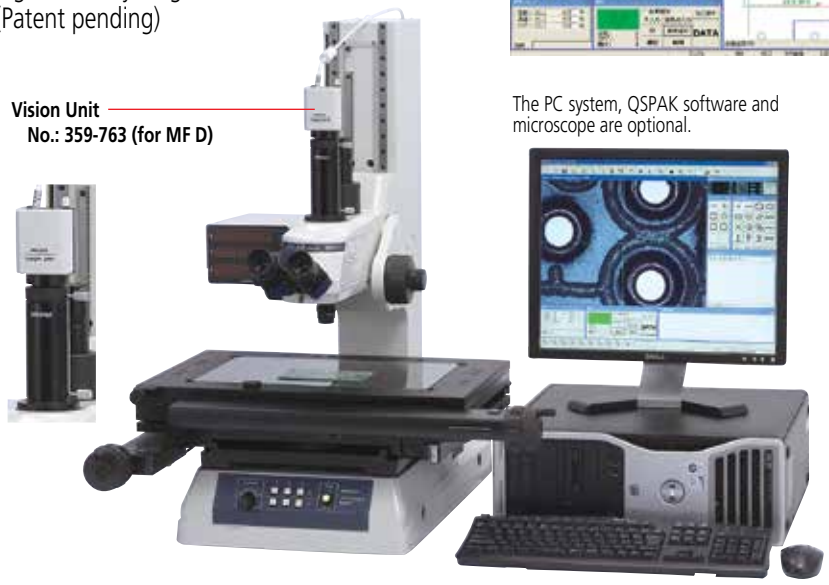
- The automatic edge-detection tools and various macro icons allow measurement in one easy step.
- The graphics and measurement navigation functions facilitate operation.
- Image data input/storage function.
- Measurement results are output in CVS format. This lets the user generate an inspection table in MS-Excel®.
- Allows the tolerance zone measurement of measurement results and various types of statistical processing for each item.
- Combined use with the focus pilot provides high-accuracy height measurements. (Patent pending)
- A series of measuring operations can be performed using just one screen display.
- The auto-brightness control function reproduces the type and degree of illumination required. (This function is limited to the MF/MF-U series.)

QSPAK Measurement Window

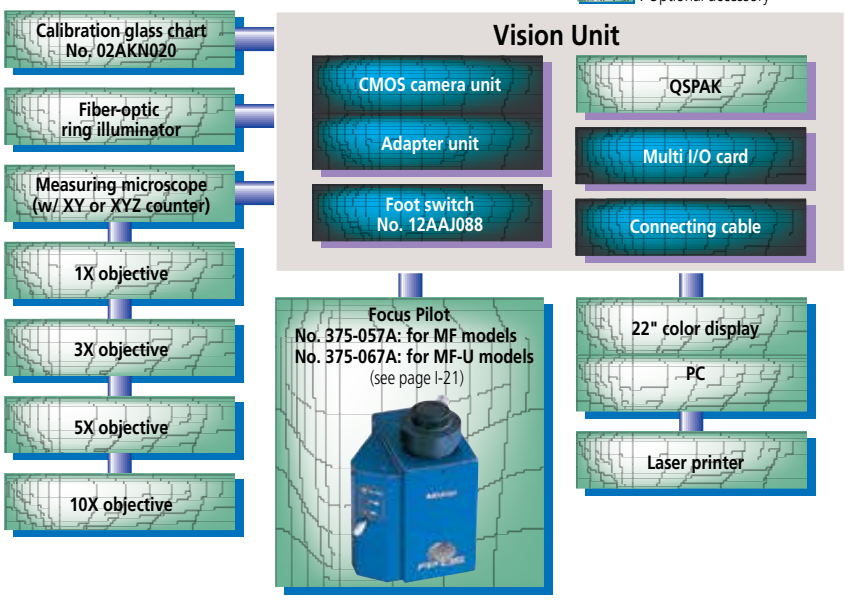


Vision Unit
No.: 359-763 (for MF D)

The PC system, QSPAK software and microscope are optional.



: Optional accessory



Mitutoyo

FS-70

SERIES 378 — Microscope Unit for Semiconductor Inspection

FEATURES

- The optical system that was developed for the best-selling FS 60 models was further enhanced for the FS70 models. It is ideal as a microscope unit of a prober station for semiconductors. (All models CE marked.)
- The FS70L supports three types of YAG laser wavelength ranges (1064nm, 532nm and 355nm), while the FS70L4 supports two types of wavelength ranges (532nm and 266nm), thus expanding a scope of laser applications, allowing laser-cutting of thin-films used in semiconductors and liquid crystal substrates. However, Mitutoyo assumes no responsibility for the performance and/or safety of the laser system used with Mitutoyo microscopes. Careful examination is recommended in selecting a laser-emission unit.
- Bright field, differential interference contrast (DIC) and polarized observations are optional with FS70Z and FS70. The FS70L and FS70L4 do not support the DIC method.
- By employing an inward revolver, the long working distance objectives provide excellent operability.
- An ergonomic design with superb operability: the FS70 employs the erect-image optical system (the image in the field of view has the same orientation as the specimen) and enlarged fine focus adjustment wheel with rubber-grip coarse adjustment knob.

FS70Z

FS70L

FS70L4

SPECIFICATIONS

Model No. **Order No.**	FS70 **378-184-1**	FS70-TH **378-184-3**	FS70Z **378-185-1**	FS70Z-TH **378-185-3**	FS70L **378-186-1**	FS70L-TH **378-186-3**	FS70L4 **378-187-1**	FS70L4-TH **378-187-3**

Short base model No. **Order No.**	FS70-S **378-184-2**	FS70-THS **378-184-4**	FS70Z-S **378-185-2**	FS70Z-THS **378-185-4**	FS70L-S **378-186-2**	FS70L-THS **378-186-4**	FS70L4-S **378-187-2**	FS70L4-THS **378-187-4**
Focus adjustment	50mm travel range with concentric coarse (3.8mm/rev) and fine (0.1mm/rev) focusing wheels (right / left)							
Image	Erect image							
Pupil distance	Siedentopf type, adjustment range: 2 - 3" / 51 - 76mm							
Field number	24							
Tilt angle	—	0° - 20°	—	0° - 20°	—	0° - 20°	—	0° - 20°
Optical pass ratio	50/50	100/0 or 0/100	50/50	100/0 or 0/100	100/0 or 0/100		100/0 or 0/100	
Protective filter	—		—		Built-in laser beam filter		Built-in laser beam filter	
Tube lens	1X		1X - 2X zoom		1X		1X	
Applicable laser	—		—		1064/532/355nm		532/266nm	
Camera mount	C-mount (using optional adapter B)				Use a laser with TV port.		C-mount receptacle (with green filter switch)	
Illumination system, optional	Reflective illumination for bright field (Koehler illumination, with aperture diaphragm) 12V 100W fiber optics, non-stepped adjustment, light guide length: 1.5m, power consumption 150W							
Objective, optional (for observation)	M Plan Apo, M Plan Apo SL, G Plan Apo							
Objective, optional (for laser-cutting)	—				M/LCD Plan NIR, M/LCD Plan NUV		M Plan UV	
Loading weight*	32lbs/14.5kg	30lbs/13.6kg	31lbs/14.1kg	29lbs/13.2kg	31lbs/14.2kg	30lbs/13.5kg	31lbs/13.9kg	29lbs/13.1kg
Mass (main unit)	13lbs/6.1kg	15.5lbs/7.1kg	14.5lbs/6.6kg	16.5lbs/7.5kg	14lbs/6.4kg	15.5lbs/7.2kg	14.5lbs/6.7kg	16.5lbs/7.5kg

*Loading weight on optical tube excluding weight of objective lenses and eyepieces.

Technical Data

Focus Adjustment Method:	With concentric coarse and fine focusing wheels (right and left)
Range:	50mm travel range 0.1mm/rev. for fine adjustment, 3.8mm/rev. for coarse adjustment
Trinocular tube Image:	Erect image
Pupil distance:	Siedentopf type, adjustment range: 2-3" / 51-76mm
Field number:	24
Tilt angle:	0° - 20° (only -TH, -THS models)
Illumination system:	Reflective illumination for bright field (Koehler illumination, with aperture diaphram)
Light source (optional):	12V100W fiber optics, non-stepped adjustment, light guide length 1.5m, power consumption 150W
Objectives (optional):	M Plan Apo, M Plan Apo SL, G Plan Apo

Optional Accessories

For a complete listing of accessories see Microscope Units and Objectives brochure, E4191-378

VMU

SERIES 378 — Video Microscope Unit

The VMU is a compact, light-weight, and easy-to-install microscope unit for CCD camera monitoring in semiconductor fabrications.

FEATURES

- The rigidity and general performance of the VMU-LB & VMU-L4B have been enhanced compared to previous models.
- The optical system features ultra-long working distance objectives and correction for the wide range of radiation.
- The fiber-optic reflected illumination keeps the workpiece free from thermal expansion caused by heat. The fiber-optic illuminator is required for the light source.
- Also available with a laser mount or revolving nosepiece (objective mount).

SPECIFICATIONS

Magnification of tube		1X
Applicable wavelength	378-505, 378-506	Near-infrared and visible radiation
	378-507 378-513	Near-infrared —visible— near-ultraviolet radiation
	378-508	Visible and ultraviolet radiation
	378-514	Near-infrared to ultraviolet
Objective		(Optional) see pg. I-28 thru I-32
Reflected illumination		• Telecentric system with aperture stop system. • Fiber-optic illuminator (optional) is required.
Light source		Halogen bulb (21V, 150W) (optional)
Mass		**378-505**: 570g **378-506**: 590g **378-507**: 980g **378-508**: 1010g **378-513**: 1300g **378-514**: 1300g

Selection Guide of System Configuration

Order No. (Depends on each system configuration)	VMU-V **378-505**	VMU-H **378-506**	VMU-L **378-507**	VMU-L4 **378-508**	VMU-LB **378-513**	VMU-L4B **378-514**
Vertical CCD camera mount	●		●	●	●	●
Horizontal CCD camera mount		●				
YAG laser mount			●	●	●	●
Fiber-optic illumination unit			▲	▲	▲	▲
M Plan Apo, M Plan Apo SL, G Plan Apo objectives for bright field observation	▲	▲	▲	▲	▲	▲
M Plan Apo NIR, LCD Plan Apo NIR, M Plan Apo NUV and LCD Plan Apo NUV objectives for laser cutting			▲		▲	▲
M Plan UV objectives for laser machining				▲		▲

●: Provided, ▲: Available as optional accessory

Wide VMU:

FEATURES

- Offers approximately 7 times larger inspection area.
- Increases throughput by allowing for batch measurements.
- BD models can accommodate darkfield optics.

378-515 WIDE VMU-V
378-516 WIDE VMU-H
378-517 WIDE VMU-BDV
378-518 WIDE VMU-BDH

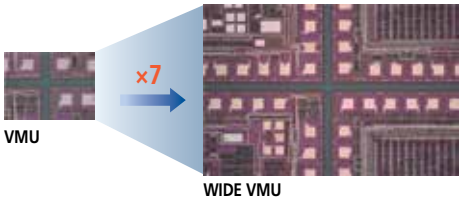
Technical Data

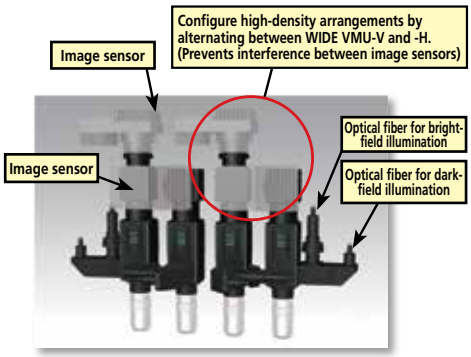
FOV in Camera Port	30mm Diameter
Camera Mount	F Mount (with C mount Adapter)
Example Sensor Size	APS-C format (2 inches)

Wide VMU Accessories

378-724	BF Revolver
378-725	BD Revolver
378-726	BF Motorized Revolver
378-727	BD Motorized Revolver

WIDE VMU-V WIDE VMU-H





Mitutoyo

Eyepieces
SERIES 378

FEATURES
- The field of view is extra wide.
- Optional reticles are available.

378-866 **378-857** **378-858**

SPECIFICATIONS

Order No. (2pcs. set)	Magnification	Field number	Mass	Individual order No.
378-866	10X	24	85g	**378-856-5**
378-857	15X	16	40g	**378-857-5**
378-858	20X	12	55g	

Reticles (optional)
516848: Cross-hair
516576: Broken cross hair (90° and 60°)
516578: Concentric circle (Diametric increment: 1.2mm)
516577: 20mm scale (Minimum reading: 0.1mm) with cross hair
516849: 10mm scale (Minimum reading: 0.1mm)
516850: 5mm scale (Minimum reading: 0.05mm)

Objectives
SERIES 378

The Mitutoyo 378 Series objectives have the world's longest working distance and an infinity correction optical system. These objectives provide flexible observation at high magnifications and independent correction of chromatic aberration.

FEATURES
- The long working distance objectives provide excellent clearance between the lens surface and the workpiece surface in focus, making it possible to observe workpieces which are usually hard-to-focus because of awkward projections.
- The metallurgical plan apochromatic (M Plan Apo) objective provides a flat, chromatic aberration-free image throughout the field of view, making it suitable for any type of microscope.
- Specially designed objectives also are available with correction for near-infrared radiation, near-ultraviolet radiation, and ultraviolet radiation, or various thicknesses of LCD screen glasses.
- The mounting screw threads of objectives are designed to conform to JIS B-7141-1988.

M Plan Apo and M Plan Apo SL objectives for bright field observation

BD Plan Apo and BD Plan Apo SL objectives for bright/dark field observation

Near-infrared radiation corrected M Plan Apo NIR objectives

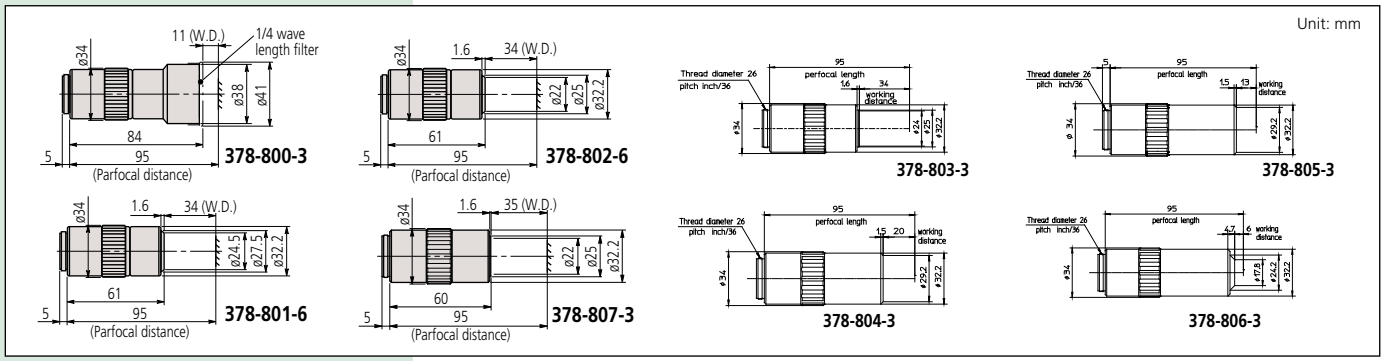
Near-ultraviolet radiation corrected M Plan Apo NUV objectives

Ultraviolet radiation corrected M Plan UV objectives

M Plan Apo for Bright Field Observation

Order No.	Mag.	N.A.	W.D.	f	R	D.F.	View field 1	View field 2	Mass
378-800-3	1X	0.025	11.0mm	200mm	11.0μm	440μm	ø24mm	4.8x6.4mm	300g
378-801-6	2X	0.055	34.0mm	100mm	5.0μm	91μm	ø12mm	2.4x3.2mm	220g
378-802-6	5X	0.14	34.0mm	40mm	2.0μm	14.0μm	ø4.8mm	0.96x1.28mm	230g
378-807-3	7.5X	0.21	35.0mm	26.67mm	1.3μm	6.2μm	ø3.6mm	0.64x0.85mm	240g
378-803-3	10X	0.28	34.0mm	20mm	1.0μm	3.5μm	ø2.4mm	0.48x0.64mm	240g
378-804-3	20X	0.42	20.0mm	10mm	0.7μm	1.6μm	ø1.2mm	0.24x0.32mm	270g
378-805-3	50X	0.55	13.0mm	4mm	0.5μm	0.9μm	ø0.48mm	0.10x0.13mm	290g
378-806-3	100X	0.70	6.0mm	2mm	0.4μm	0.6μm	ø0.24mm	0.05x0.06mm	320g

DIMENSIONS

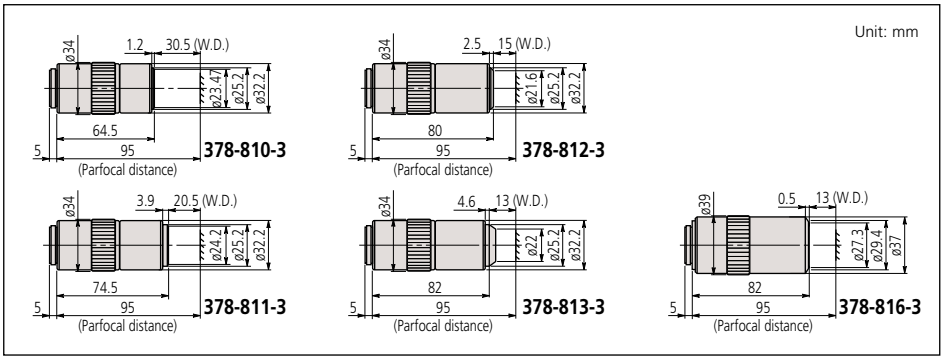


Note:
These objectives offer extra-long working distance.

M Plan Apo SL for Bright Field Observation

Order No.	Mag.	N.A.	W.D.	f	R	D.F.	View field 1	View field 2	Mass
378-810-3	20X	0.28	30.5mm	10mm	1.0μm	3.5μm	ø1.2mm	0.24x0.32mm	240g
378-811-3	50X	0.42	20.5mm	4mm	0.7μm	1.6μm	ø0.48mm	0.10x0.13mm	280g
378-812-3	80X	0.50	15.0mm	2.5mm	0.6μm	1.1μm	ø0.3mm	0.06x0.08mm	280g
378-813-3	100X	0.55	13.0mm	2mm	0.5μm	0.9μm	ø0.24mm	0.05x0.06mm	290g
378-816-3	200X	0.62	13.0mm	1mm	0.4μm	0.7μm	ø0.12mm	0.025x0.03mm	490g

DIMENSIONS

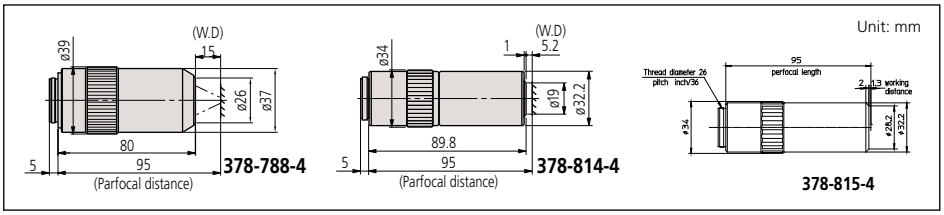


Note:
These objectives offer extra-high resolving power.

M Plan Apo HR for Bright Field Observation

Order No.	Mag.	N.A.	W.D.	f	R	D.F.	View field 1	View field 2	Mass
378-787-4	5X	0.21	25.5mm	40mm	1.3μm	6.2μm	ø4.8mm	0.96x1.28mm	285g
378-788-4	10X	0.42	15mm	20mm	0.7μm	1.6μm	ø2.4mm	0.48x0.64mm	460g
378-814-4	50X	0.75	5.2mm	4mm	0.4μm	0.49μm	ø0.48mm	0.10x0.13mm	400g
378-815-4	100X	0.90	1.3mm	2mm	0.3μm	0.34μm	ø0.24mm	0.05x0.06mm	410g

DIMENSIONS



Mag.: Magnification
N.A.: Numerical aperture
W.D.: Working distance
f: Focal distance
R: Resolving power
D.F.: Focal depth
View field 1:
Field of view when using ø24mm eyepiece
View field 2:
Field of view when using 1/2" CCD camera

Glass Thickness (t = 3.5mm) Corrected
G Plan Apo for Bright Field Observation

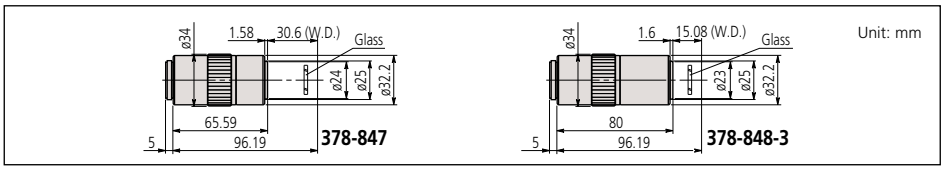
Order No.	Mag.	N.A.	W.D.	f	R	D.F.	View field 1	View field 2	Mass
378-847	20X	0.28	29.42mm*	10mm	1.0μm	3.5μm	ø1.2mm	0.24x0.32mm	270g
378-848-3	50X	0.50	13.89mm*	4mm	0.6μm	1.1μm	ø0.48mm	0.10x0.13mm	320g

*In air

Note:
The G Plan Apo Series are designed for observing a workpiece through BK-7 glass (thickness = 3.5mm).

DIMENSIONS

Unit: mm

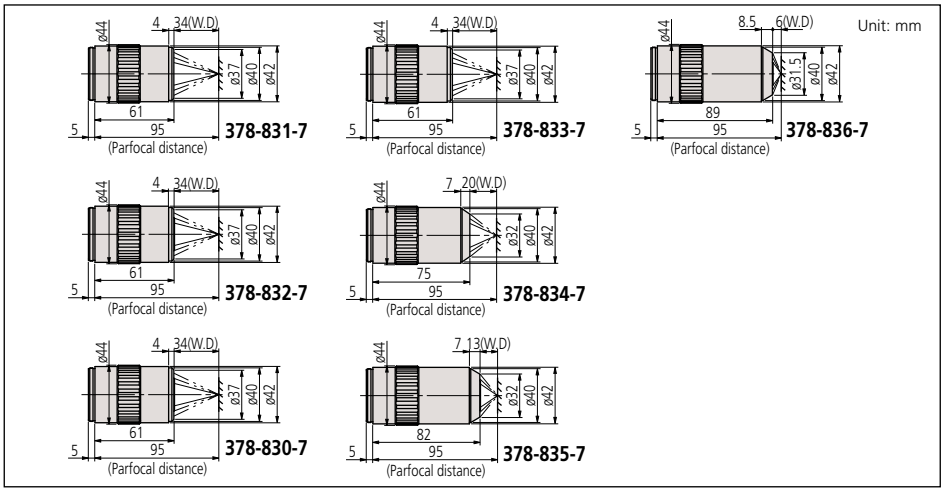


BD Plan Apo for Bright/Dark Field Observation

Order No.	Mag.	N.A.	W.D.	f	R	D.F.	View field 1	View field 2	Mass
378-831-7	2X	0.055	34.0mm	100mm	5.0μm	91μm	ø12mm	2.4x3.2mm	340g
378-832-7	5X	0.14	34.0mm	40mm	2.0μm	14.0μm	ø4.8mm	0.96x1.28mm	350g
378-830-7	7.5X	0.21	34.0mm	26.67mm	1.3μm	6.2μm	ø3.6mm	0.64x0.85mm	350g
378-833-7	10X	0.28	34.0mm	20mm	1.0μm	3.5μm	ø2.4mm	0.48x0.64mm	350g
378-834-7	20X	0.42	20.0mm	10mm	0.7μm	1.6μm	ø1.2mm	0.24x0.32mm	400g
378-835-7	50X	0.55	13.0mm	4mm	0.5μm	0.9μm	ø0.48mm	0.10x0.13mm	440g
378-836-7	100X	0.70	6.0mm	2mm	0.4μm	0.6μm	ø0.24mm	0.05x0.06mm	460g

DIMENSIONS

Unit: mm



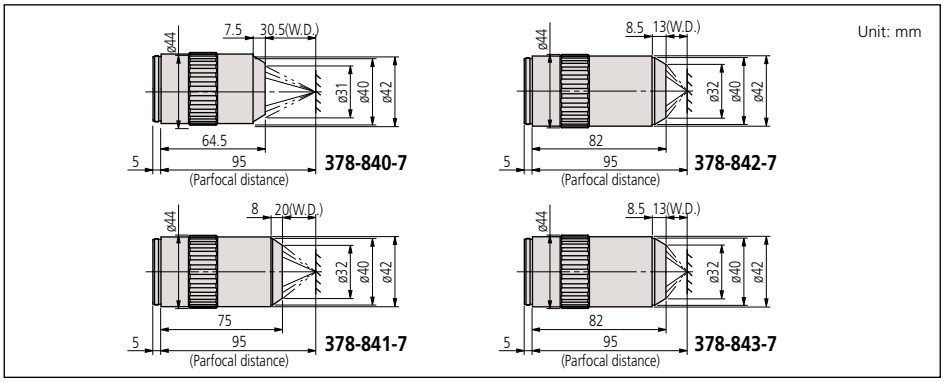
BD Plan Apo SL for Bright/Dark Field Observation

Order No.	Mag.	N.A.	W.D.	f	R	D.F.	View field 1	View field 2	Mass
378-840-7	20X	0.28	30.5mm	10mm	1.0μm	3.5μm	ø1.2mm	0.24x0.32mm	350g
378-841-7	50X	0.42	20.0mm	4mm	0.7μm	1.6μm	ø0.48mm	0.10x0.13mm	410g
378-842-7	80X	0.50	13.0mm	2.5mm	0.6μm	1.1μm	ø0.3mm	0.06x0.08mm	430g
378-843-7	100X	0.55	13.0mm	2mm	0.5μm	0.9μm	ø0.24mm	0.05x0.06mm	440g

Note:
These objectives offer extra-long working distance.

DIMENSIONS

Unit: mm



Mag.: Magnification
N.A.: Numerical aperture
W.D.: Working distance
f: Focal distance
R: Resolving power
D.F.: Focal depth
View field 1: Field of view when using ø24mm eyepiece
View field 2: Field of view when using 1/2" CCD camera

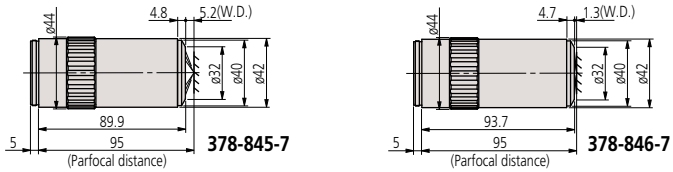
Note:
These objectives offer extra-high resolving power.

BD Plan Apo HR for Bright/Dark Field Observation

Order No.	Mag.	N.A.	W.D.	f	R	D.F.	View field 1	View field 2	Mass
378-845-7	50X	0.75	5.2mm	4mm	0.4μm	0.49μm	ø0.48mm	0.10x0.13mm	530g
378-846-7	100X	0.90	1.3mm	2mm	0.3μm	0.34μm	ø0.24mm	0.05x0.06mm	545g

DIMENSIONS

Unit: mm



Note:
These objectives are designed so that a workpiece's image can be focused within the focal depth even when the wavelength is changed anywhere from the visible range (l = 480nm) up to near-infrared range (l = 1800nm). Therefore, the M Plan NIR Series are suitable for laser repair. However, when the wavelength used exceeds 1100nm, the focusing position may slightly deviate from that in the visible range due to changes in glass dispersion and refractive index.

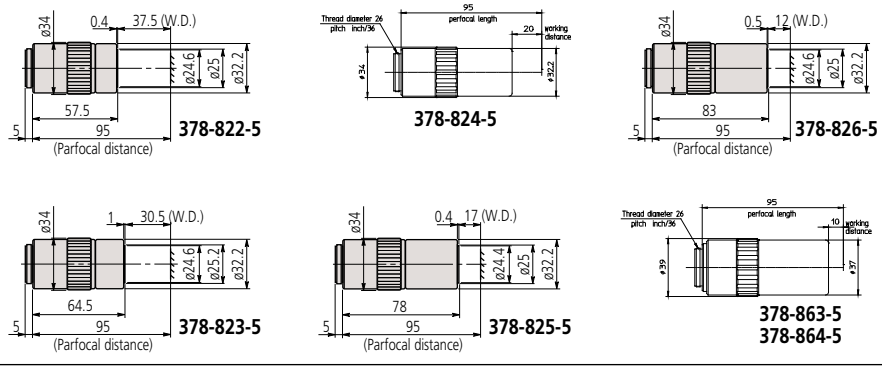
Near-infrared Radiation Corrected M Plan Apo NIR for Bright Field Observation

Order No.	Mag.	N.A.	W.D.	f	R	D.F.	View field 1	View field 2	Mass
378-822-5	5X	0.14	37.5mm	40mm	2.0μm	14.0μm	ø4.8mm	0.96x1.28mm	220g
378-823-5	10X	0.26	30.5mm	20mm	1.1μm	4.1μm	ø2.4mm	0.48x0.64mm	250g
378-824-5	20X	0.40	20.0mm	10mm	0.7μm	1.7μm	ø1.2mm	0.24x0.32mm	300g
378-825-5	50X	0.42	17.0mm	4mm	0.7μm	1.6μm	ø0.48mm	0.10x0.13mm	315g
378-826-5	100X	0.50	12.0mm	2mm	0.6μm	1.1μm	ø0.24mm	0.05x0.06mm	335g
378-863-5*	50X	0.65	10mm	4mm	0.4μm	0.7μm	ø0.48mm	0.10x0.13mm	450g
378-864-5*	100X	0.70	10mm	2mm	0.4μm	0.6μm	ø0.24mm	0.05x0.06mm	450g

* High Resolution (HR objectives)

DIMENSIONS

Unit: mm



Note:
These objectives are designed so that a workpiece's image can be focused within the focal depth even when the wavelength is changed anywhere from the visible range (l = 620nm) to the near-ultraviolet range (l = 355nm). Therefore The M Plan NUV Series are suitable for laser repair using a high frequency laser beam.

Mag.: Magnification
N.A.: Numerical aperture
W.D.: Working distance
f: Focal distance
R: Resolving power
D.F.: Focal depth
View field 1: Field of view when using ø24mm eyepiece
View field 2: Field of view when using 1/2" CCD camera

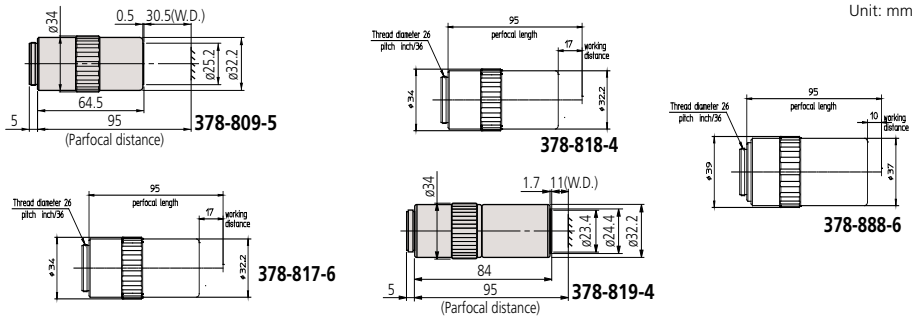
Near-ultraviolet Radiation Corrected M Plan Apo NUV for Bright Field Observation

Order No.	Mag.	N.A.	W.D.	f	R	D.F.	View field 1	View field 2	Mass
378-809-5	10X	0.28	30.5mm	20mm	1μm	3.5μm	ø2.4mm	0.48x0.64mm	255g
378-817-6	20X	0.40	17.0mm	10mm	0.7μm	1.7μm	ø1.2mm	0.24x0.32mm	340g
378-818-4	50X	0.42	15.0mm	4mm	0.7μm	1.6μm	ø0.48mm	0.10x0.13mm	350g
378-819-4	100X	0.50	11.0mm	2mm	0.6μm	1.1μm	ø0.24mm	0.05x0.06mm	380g
378-888-6*	50X	0.65	10.00mm	4mm	0.42μm	0.65μm	ø0.48mm	0.10x0.13mm	500g

*High resolution (HR objective)

DIMENSIONS

Unit: mm



Near-Infrared Radiation and LCD Glass Thickness (t = 1.1mm or 0.7mm) Corrected LCD Plan Apo NIR for Bright Field Observation

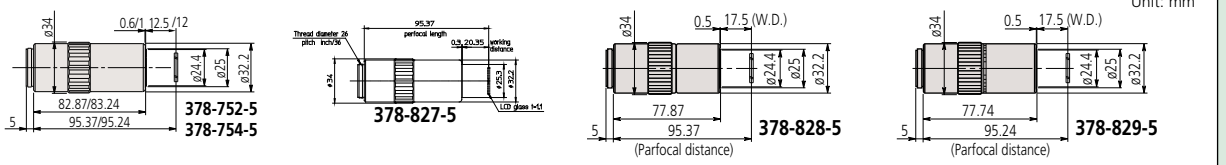
Order No.	Mag.	N.A.	W.D.	f	R	D.F.	View field 1	View field 2	Mass
378-827-5	20X (t1.1)	0.40	19.98mm*	10mm	0.7µm	1.7µm	ø1.2mm	0.24x0.32mm	305g
378-828-5	50X (t1.1)	0.42	17.13mm*	3.9mm	0.7µm	1.6µm	ø0.48mm	0.10x0.13mm	320g
378-829-5	50X (t0.7)	0.42	17.26mm*	3.9mm	0.7µm	1.6µm	ø0.48mm	0.10x0.13mm	320g
378-752-5	100X (t1.1)	0.50	12.13mm*	2mm	0.6µm	1.1µm	ø0.24mm	0.05x0.06mm	335g
378-754-5	100X (t0.7)	0.50	11.76mm*	2mm	0.6µm	1.1µm	ø0.24mm	0.05x0.06mm	335g

*In air

Note:
These near-infrared (l = 1800nm) corrected objectives are designed for observing a workpiece through LCD glass (thickness = 1.1mm (**378-827-5**, **378-828-5, 378-752-5**) or 0.7mm (**378-829-5**, **378-754-5**) and for laser repair.

DIMENSIONS

Unit: mm



Near-ultraviolet Radiation and LCD Glass Thickness (t = 0.7mm) Corrected LCD Plan Apo NUV for Bright Field Observation

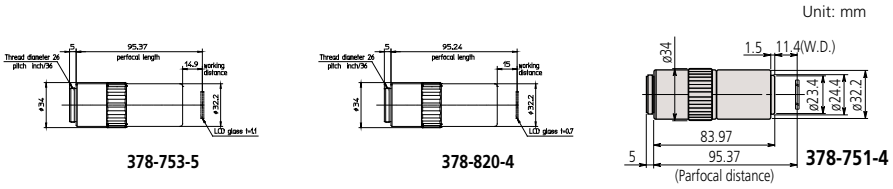
Order No.	Mag.	N.A.	W.D.	f	R	D.F.	View field 1	View field 2	Mass
378-890-6	20X (t0.7)	0.4	16.96mm*	10mm	0.7µm	1.7µm	ø1.2mm	0.24x0.32mm	340g
378-891-6**	50X (t0.7)	0.65	9.76mm*	4mm	0.42µm	0.65µm	ø0.48mm	0.10x0.13mm	500g
378-820-6	50X (t0.7)	0.42	14.76mm*	4mm	0.7µm	1.6µm	ø0.48mm	0.10x0.13mm	310g
378-753-6	50X (t1.1)	0.42	14.53mm	4mm	0.7µm	1.6µm	ø0.48mm	0.10x0.13mm	310g
378-751-4	100X(t1.1)	0.50	11.03mm	2mm	0.6µm	1.1µm	ø0.24mm	0.05x0.06mm	380g

* In air
** High-Resolution (HR Objectives)

Note:
These near ultraviolet corrected objectives are designed for observing a workpiece through LCD glass (thickness = 1.1mm (**378-753-6, 378-751-4**) or 0.7mm (**378-820-6**) and for laser repair.

DIMENSIONS

Unit: mm



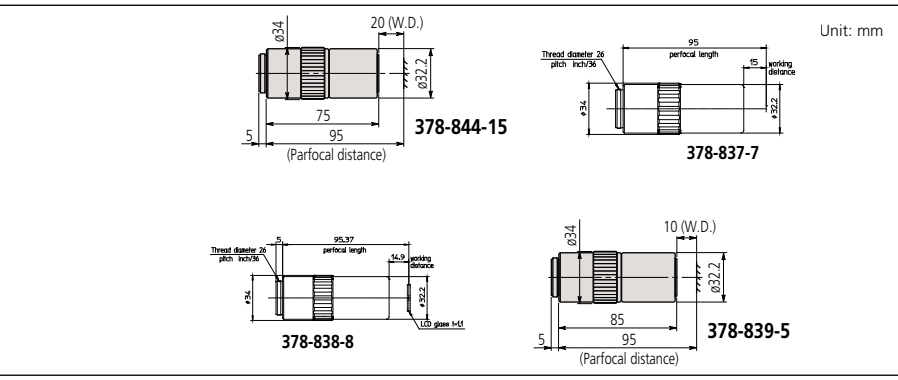
Ultraviolet Radiation Corrected M Plan UV for Bright Field Observation

Order No.	Mag.	N.A.	W.D.	f	R	D.F.	View field 1	View field 2	Mass
378-844-15	10X	0.25	20mm	20mm	1.1µm	4.4µm	ø2.4mm	0.48x0.64mm	310g
378-837-7	20X	0.36	15.0mm	10mm	0.8µm	2.1µm	ø1.2mm	0.24x0.32mm	330g
378-838-8	50X	0.41	12.0mm	4mm	0.7µm	1.7µm	ø0.48mm	0.10x0.13mm	400g
378-839-5	80X	0.55	10.0mm	2.5mm	0.5µm	0.9µm	ø0.3mm	0.06x0.08mm	380g

Note:
These ultraviolet corrected objectives are designed so that a workpiece's image can be focused within the focal depth even when the wavelength is changed anywhere from the visible range (l = 550nm) to the ultraviolet range (l = 266nm). Therefore the M Plan UV Series are suitable for laser repair using a high-frequency laser beam.

DIMENSIONS

Unit: mm



Mag.: Magnification
N.A.: Numerical aperture
W.D.: Working distance
f: Focal distance
R: Resolving power
D.F.: Focal depth
View field 1: Field of view when using ø24mm eyepiece
View field 2: Field of view when using 1/2" CCD camera

MSM-400

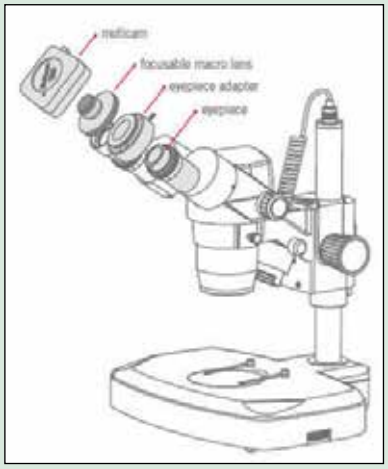
SERIES 377 — Stereo Microscopes

Digital Imaging with Software

Order No.	Description
64AAB429	MOTICAM 2, 2.0 MEGAPIXEL-1/3" CMOS, USB
64AAB529	MOTICAM 3+, 3.0 MEGAPIXEL-1/2" CMOS, USB
64AAB431	MOTICAM 5, 5.0 MEGAPIXEL-1/2.5" CMOS, USB
64AAB526	MOTICAM 1080, 2.0 MEGAPIXEL-1/2.8" CMOS, USB/HDMI

Optional Accessories

Order No.	Description
64AAB214	LED Variable Ring Light
64PMI237	MOTICAM EYETUBE ADAPTOR (for TM Scopes)




Motic Images Plus 2.0 - Measurements

FEATURES

- Continuous 1X - 4X magnification
- Image always in focus throughout zoom range
- Crisp, erect images with high resolution and excellent stereoscopic effect
- Stereo-tube can be rotated a full 360°, for viewing at any angle
- Bilateral zoom control knob adds convenience and increases operator efficiency
- Diopter adjustment for both eyepieces
- Binocular tube inclination: 45°
- Focusing range: 1.46" (37mm)
- Interpupillary adjustable range: 2.12" - 2.99" (54mm - 76mm)
- Optional zoom ranges from 2.5X - 10X to 30X - 120X

The MSM-414L is a traditional binocular stereo microscope for industrial, medical and classroom applications. It is ideal for electrical small part inspection, assembly, and medical/ biological dissection.

Optional Accessories

Illuminated Stand

Order No.	Description
377-412	Pole-Type Stand (top: 12V/10W flat filament tungsten, bottom: 5W fluorescent
377-413*	Pole-Type Stand (top: 12V/10W flat filament tungsten, bottom: 12V/10W halogen with intensity control)
377-414	Fixed-Arm Stand (top: 12V/10W flat filament tungsten, bottom: 5W fluorescent)
377-415	Fixed-Arm Stand (top: 12V/10W flat filament tungsten, bottom: 12V/10W halogen with intensity control)
377-416	Fixed-Arm Stand (top: 5W fluorescent, bottom: 5W fluorescent)

*Standard Accessory

377-972A

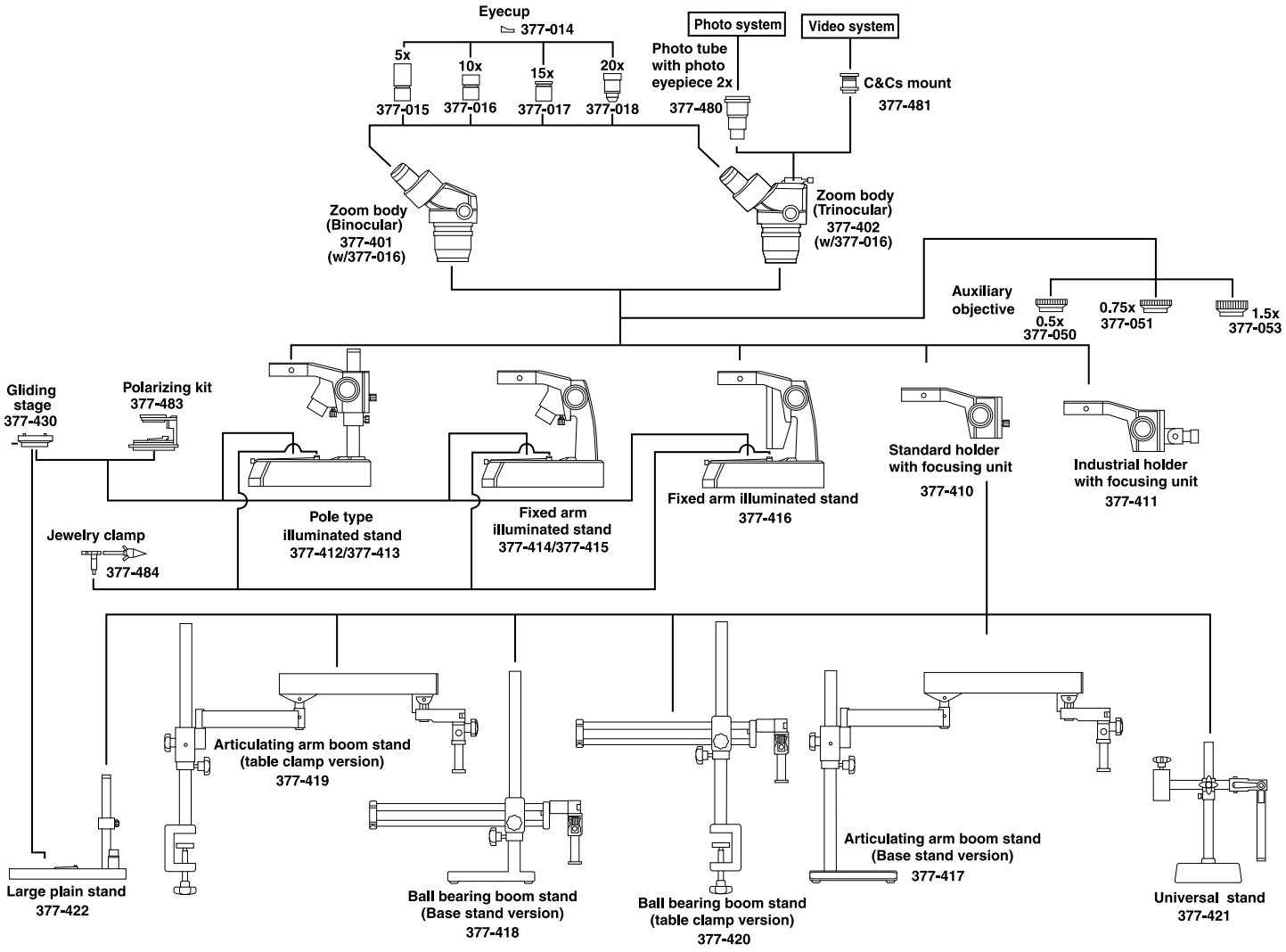
SPECIFICATIONS

Model.	MSM-414L	MSM-414TL
Order No.	**377-972A**	**377-974A**
Optical tube	Binocular	Trinocular
Total magnification	10X - 40X	
Eyepiece	10X (377-016)	
Objective	1X - 4X	
Working distance	80mm	
Field of view	20mm - 5mm	
Dimensions	H=13.2"x W=6.7"x D=9.3"	
Mass	13.2 lbs (6kg)	

Stereo Microscopes

SERIES 377

377-972A/377-974A SYSTEM DIAGRAM



MSM-400

SERIES 377 — Stereo Microscopes

FEATURES

- Superior quality optics provide high-resolution
- Crystal sharp, high-color contrast image with excellent depth of field
- Always in sharp focus at all magnifications
- The Parfocal Optical System allows relaxed strain-free viewing
- Long working distance
- Extreme large field of view (23mm diameter)

The MSM-465L, Order No. 377-990A, is a high-accuracy four-step magnification stereo microscope. With a horizontal changer allowing 6X, 12X, 25X, and 50X magnifications with a standard 1X objective and 10X eyepieces, the MSM-465L has limitless capabilities for electrical small part inspection.

The MSM-464L, Order No. 377-991A, with its vertical five-step magnification changer is ideal for small part assembly. This stereo microscope with standard 6.4X, 10X, 16X, 25X, and 40X magnifications, has flexibility from 3.2X to 160X magnifications.

MSM-465L
377-990A

MSM-464L
377-991A

Optional Accessories

Video System

Order No.	Description
377-488	Video System* for 377-990A
377-489	Video System* for 377-991A

* Converts Binocular to Trinocular

Accessories

Order No.	Description
64AAB214	LED variable ring light

Digital Imaging with Software

Order No.	Description
64AAB429	MOTICAM 2, 2.0 MEGAPIXEL-1/3" CMOS, USB
64AAB529	MOTICAM 3+, 3.0 MEGAPIXEL-1/2" CMOS, USB
64AAB431	MOTICAM 5, 5.0 MEGAPIXEL-1/2.5" CMOS, USB
64AAB526	MOTICAM 1080, 2.0 MEGAPIXEL-1/2.8" CMOS, USB/HDMI

SPECIFICATIONS

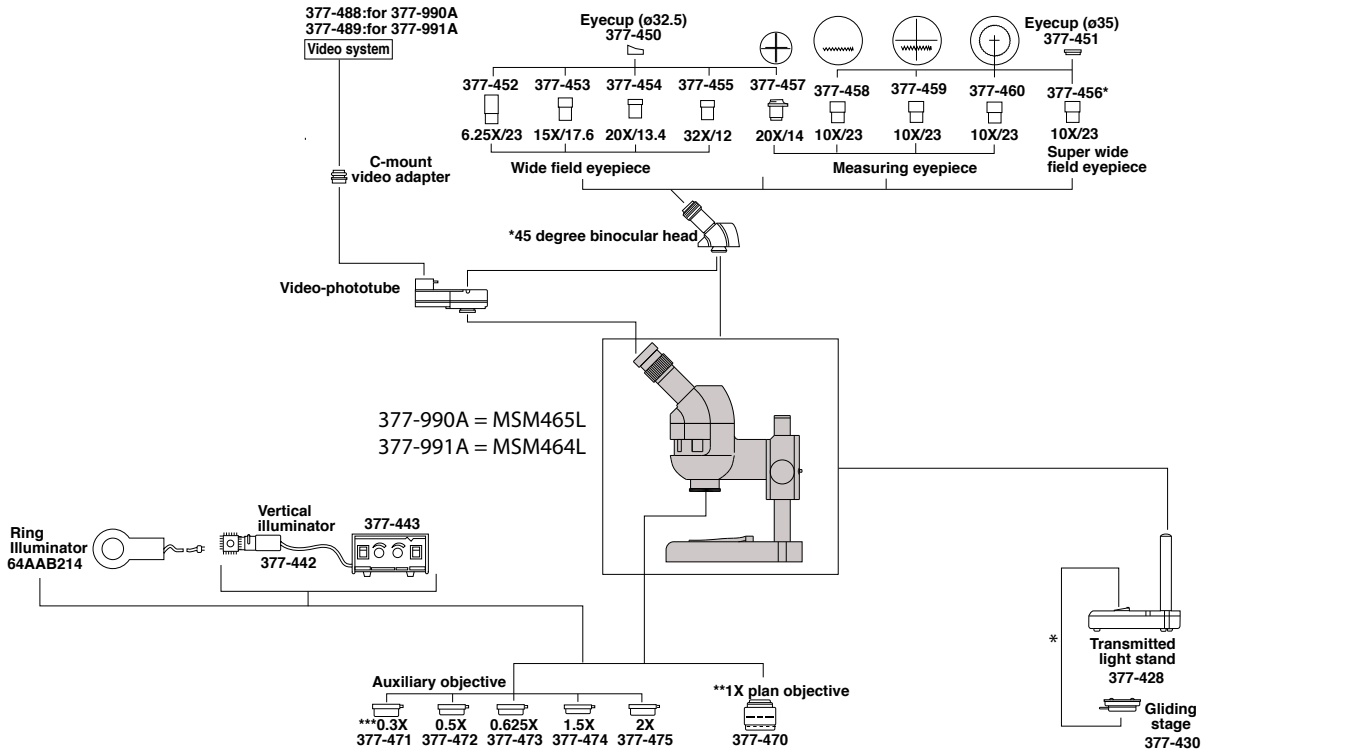
Model. Order No.	MSM-465L 377-990A	MSM-464TL 377-991A
Optical tube	Binocular*	Binocular*
Total magnification	6X - 50X	6.4X - 40X
Eyepiece	10X (377-456)	10X (377-456)
Objective	.6X, 1.2X, 2.5X, 5X	.6X, 1X, 1.6X, 2.5X, 4X
Working distance	89mm	89mm
Field of view	23mm (w/377-456)	23mm (w/377-456)
Dimensions	H=14.6"x W=13"x D=11"	H=14.3"x W=13"x D=11"
Mass	15.5 lbs (7kg)	15.5 lbs (7kg)
Stand	Transmitted Light Stand (377-428)	Transmitted Light Stand (377-428)

* For Video System, see upper left table (optional accessories)

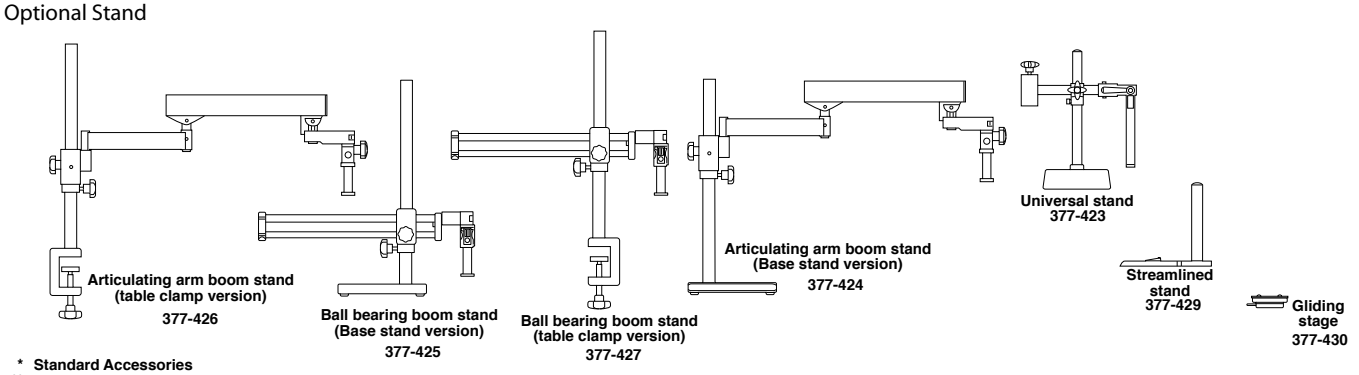
Stereo Microscopes

SERIES 377

377-990A/377-991A SYSTEM DIAGRAM



Optional Stand



* Standard Accessories
** 1X plan objective can replace 1X standard built-in objective
*** 350mm long stand post is required. (377-431)

Pocket Magnifiers

SERIES 183

FEATURES

- Suitable for inspecting metal surfaces.

SPECIFICATIONS

Magnification	Order No.	Remarks
25X	**183-201**	Pen type
	183-202	With stand
50X	**183-203**	With stand

183-201

183-202

183-203

Pocket Comparators

SERIES 183

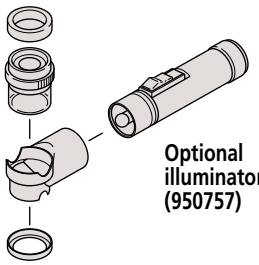
FEATURES

- By replacing optional reticles, dimensional, angle and other types of measurements can be performed.
- Illuminator (**950757**) is available.

SPECIFICATIONS

Magnification	Order No.	Remarks
8X	**183-101**	Optional reticles available
10X	**183-131**	Optional reticles available

183-101



Optional illuminator (950757)

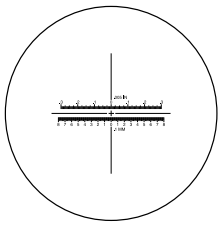
Zoom Loupe

SERIES 183

FEATURES

- Allows the user 8X - 16X zoom observation.
- Magnification indicator is provided for 8X, 10X, 12X, 14X and 16X observation.
- Metric and inch scales are provided for measuring.
- Comes with a carrying case.

183-304



Reticle provided

SPECIFICATIONS

Magnification	Order No.	Remarks
8X - 16X	**183-304**	With reticle (Scale graduation: 0.1mm, .005"

Clear Loupe

SERIES 183

183-301 **183-302** **183-303**

SPECIFICATIONS

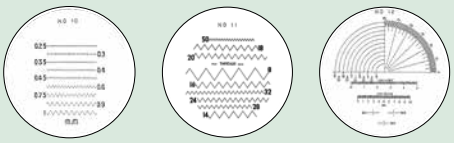
Magnification	Order No.	Remarks
7X	**183-301**	Drawtube removable
10X	**183-302**	Drawtube removable
15X	**183-303**	Drawtube removable

Optional Reticles for Pocket Comparators

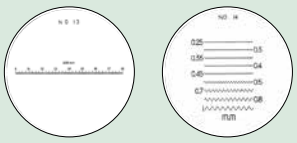
183-102 **183-103** **183-104**

183-105 **183-106** **183-107**

183-108 **183-109** **183-110**



183-111 **183-112** **183-113**



183-114 **183-115**

Pocket Comparator 8X with Reticles Set

Set No.

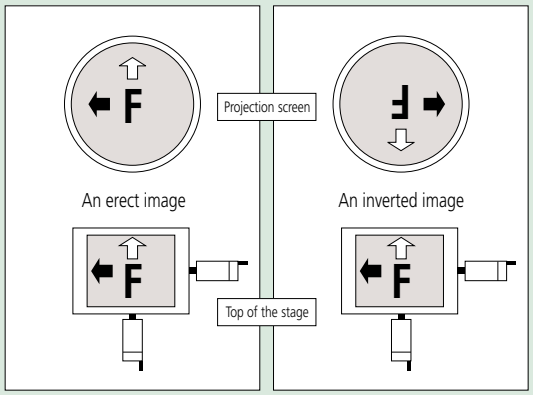
183-901	183-101, 183-106
183-902	183-101, 183-102, 183-106, 183-107, 183-112, 183-113, 183-114
183-903	183-101, 183-102, 183-106, 183-107, 183-109, 183-113, 183-115
183-904	183-101, 183-102

Mitutoyo

Quick Guide to Precision Measuring Instruments

Erect Image and Inverted Image

An image of an object projected onto a screen is erect if it is orientated the same way as the object on the stage. If the image is reversed top to bottom, left to right and by movement with respect to the object on the stage (as shown in the figure below) it is referred to as an inverted image (also known as a reversed image, which is probably more accurate).



F Workpiece
⬅ X-axis movement
⇦ Y-axis movement

Magnification Accuracy

The magnification accuracy of a projector when using a certain lens is established by projecting an image of a reference object and comparing the size of the image of this object, as measured on the screen, with the expected size (calculated from the lens magnification, as marked) to produce a percentage magnification accuracy figure, as illustrated below. The reference object is often in the form of a small, graduated glass scale called a stage micrometer or standard scale, and the projected image of this is measured with a larger glass scale known as a reading scale.

(Note that magnification accuracy is not the same as measuring accuracy.)

$$\Delta M(\%) = \frac{L - \ell M}{\ell M} \times 100$$

ΔM(%): Magnification accuracy expressed as a percentage of the nominal lens magnification
L : Length of the projected image of the reference object measured on the screen
ℓ : Length of the reference object
M : Magnification of the projection lens

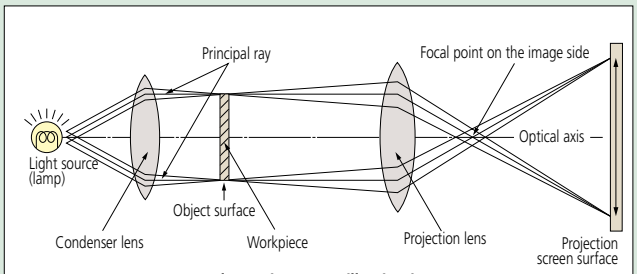
Type of Illumination

- Contour illumination: An illumination method to observe a workpiece by transmitted light and is used mainly for measuring the magnified contour image of a workpiece.
- Coaxial surface illumination: An illumination method whereby a workpiece is illuminated by light transmitted coaxially to the lens for the observation/measurement of the surface. (A half-mirror or a projection lens with a built-in half-mirror is needed.)
- Oblique surface illumination: A method of illumination by obliquely illuminating the workpiece surface. This method provides an image of enhanced contrast, allowing it to be observed three-dimensionally and clearly. However, note that an error is apt to occur in dimensional measurement with this method of illumination.
  (An oblique mirror is needed. Models in the PJ-H30 series are supplied with an oblique mirror.)

Telecentric Optical System

An optical system based on the principle that the principal ray is aligned parallel to the optical axis by placing a lens stop on the focal point on the image side. Its functional feature is that the image will not vary in size though the image blurs as the object is shifted along the optical axis.

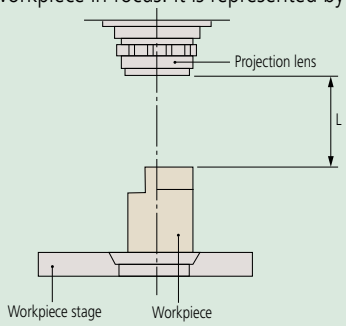
For measuring projectors and measuring microscopes, an identical effect is obtained by placing a lamp filament at the focal point of a condenser lens instead of a lens stop so that the object is illuminated with parallel beams. (See the figure below.)



Telecentric contour illumination

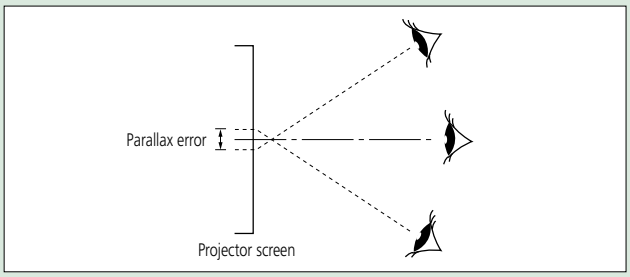
Working distance

Refers to the distance from the face of the projection lens to the surface of a workpiece in focus. It is represented by L in the diagram below.



Parallax error

This is the displacement of an object against a fixed background caused by a change in the observer's position and a finite separation of the object and background planes.



Field of view diameter

The maximum diameter of workpiece that can be projected using a particular lens.

$$\text{Field of view diameter (mm)} = \frac{\text{Screen diameter of profile projector}}{\text{Magnification of projection lens used}}$$

Example: If a 5X magnification lens is used for a projector with a screen of ø500mm:
Field of view diameter is given by $\frac{500\text{mm}}{5} = 100\text{mm}$

Numerical Aperture (NA)

The NA figure is important because it indicates the resolving power of an objective lens. The larger the NA value the finer the detail that can be seen. A lens with a larger NA also collects more light and will normally provide a brighter image with a narrower depth of focus than one with a smaller NA value.

$$NA = n \cdot \sin\theta$$

The formula above shows that NA depends on n, the refractive index of the medium that exists between the front of an objective and the specimen (for air, n=1.0), and angle θ, which is the half-angle of the maximum cone of light that can enter the lens.

Resolving Power (R)

The minimum detectable distance between two image points, representing the limit of resolution. Resolving power (R) is determined by numerical aperture (NA) and wavelength (λ) of the illumination.

$$R = \frac{\lambda}{2 \cdot NA} \ (\mu m)$$

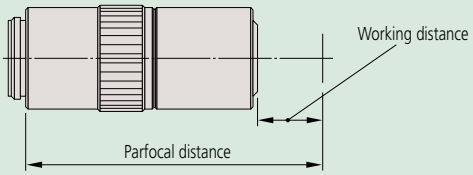
λ = 0.55μm is often used as the reference wavelength

Working Distance (W.D.)

The distance between the front end of a microscope objective and the surface of the workpiece at which the sharpest focusing is obtained.

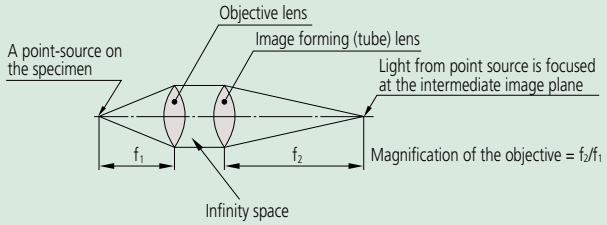
Parfocal Distance

The distance between the mounting position of a microscope objective and the surface of the workpiece at which the sharpest focusing is obtained. Objective lenses mounted together in the same turret should have the same parfocal distance so that when another objective is brought into use the amount of refocusing needed is minimal.



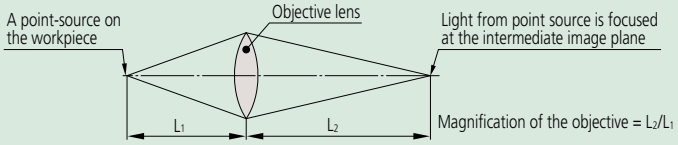
Infinity Optical System

An optical system where the objective forms its image at infinity and a tube lens is placed within the body tube between the objective and the eyepiece to produce the intermediate image. After passing through the objective the light effectively travels parallel to the optical axis to the tube lens through what is termed the infinity space within which auxiliary components can be placed, such as differential interference contrast (DIC) prisms, polarizers, etc., with minimal effect on focus and aberration corrections.



Finite Optical System

An optical system that uses an objective to form the intermediate image at a finite position. Light from the workpiece passing through the objective is directed toward the intermediate image plane (located at the front focal plane of the eyepiece) and converges in that plane.



Focal Length (f)

unit: mm

The distance from the principal point to the focal point of a lens: if f1 represents the focal length of an objective and f2 represents the focal length of an image forming (tube) lens then magnification is determined by the ratio between the two. (In the case of the infinity-correction optical system.)

$$\text{Objective magnification} = \frac{\text{Focal length of the image-forming (tube) lens}}{\text{Focal length of the objective}}$$

Example: $1X = \frac{200}{200}$ Example: $10X = \frac{200}{20}$

Focal Point

Light rays traveling parallel to the optical axis of a converging lens system and passing through that system will converge (or focus) to a point on the axis known as the rear focal point, or image focal point.

Depth of Focus (DOF)

unit: mm

Also known as depth of field, this is the distance (measured in the direction of the optical axis) between the two planes which define the limits of acceptable image sharpness when the microscope is focused on an object. As the numerical aperture (NA) increases, the depth of focus becomes shallower, as shown by the expression below:

$$DOF = \frac{\lambda}{2 \cdot (NA)^2}$$ λ = 0.55μm is often used as the reference wavelength

Example: For an **M Plan Apo 100X** lens (NA = 0.7)
The depth of focus of this objective is

$$\frac{0.55\mu m}{2 \times 0.7^2} = 0.6\mu m$$

Bright-field Illumination and Dark-field Illumination

In brightfield illumination a full cone of light is focused by the objective on the specimen surface. This is the normal mode of viewing with an optical microscope. With darkfield illumination, the inner area of the light cone is blocked so that the surface is only illuminated by light from an oblique angle. Darkfield illumination is good for detecting surface scratches and contamination.

Apochromat and Achromat Objectives

An apochromat objective is a lens corrected for chromatic aberration (color blur) in three colors (red, blue, yellow).
An achromat objective is a lens corrected for chromatic aberration in two colors (red, blue).

Quick Guide to Precision Measuring Instruments

Magnification

The ratio of the size of a magnified object image created by an optical system to that of the object. Magnification commonly refers to lateral magnification although it can mean lateral, vertical, or angular magnification.

Principal Ray

A ray considered to be emitted from an object point off the optical axis and passing through the center of an aperture diaphragm in a lens system.

Aperture Diaphragm

An adjustable circular aperture which controls the amount of light passing through a lens system. It is also referred to as an aperture stop and its size affects image brightness and depth of focus.

Field Stop

A stop which controls the field of view in an optical instrument.

Telecentric System

An optical system where the light rays are parallel to the optical axis in object and/or image space. This means that magnification is nearly constant over a range of working distances, therefore, almost eliminating perspective error.

Erect Image

An image in which the orientations of left, right, top, bottom and moving directions are the same as those of a workpiece on the workstage.

Field number (FN), real field of view, and monitor display magnification

unit: mm

The observation range of the sample surface is determined by the diameter of the eyepiece's field stop. The value of this diameter in millimeters is called the field number (FN). In contrast, the real field of view is the range on the workpiece surface when actually magnified and observed with the objective lens.
The real field of view can be calculated with the following formula:

(1) The range of the workpiece that can be observed with the microscope (diameter)

$$\text{Real field of view} = \frac{\text{FN of eyepiece}}{\text{Objective lens magnification}}$$

Example: The real field of view of a 1X lens is $24 = \frac{24}{1}$

The real field of view of a 10X lens is $2.4 = \frac{24}{10}$

(2) Monitor observation range

$$\text{Monitor observation range} = \frac{\text{The size of the camera image sensor (diagonal length)}}{\text{Objective lens magnification}}$$

• Size of image sensor

Format	Diagonal length	Length	Height
1/3″	6.0	4.8	3.6
1/2″	8.0	6.4	4.8
2/3″	11.0	8.8	6.6

(3) Monitor display magnification

$$\text{Monitor display magnification} = \text{Objective lens magnification} \times \frac{\text{Display diagonal length on the monitor}}{\text{Diagonal length of camera image sensor}}$$