

FS70

Microscope Unit

User's Manual

Read this User's Manual thoroughly
before operating the instrument. After reading,
retain it close at hand for future reference.

This English language version of the User's Manual contains the original instructions.

Mitutoyo

CONVENTIONS USED IN THIS MANUAL

Safety Precautions

To ensure that instruments are operated correctly and safely, Mitutoyo manuals use various safety symbols (Signal Words and Safety Alert Symbols) to identify and warn against hazards and potential accidents.

The following symbols indicate **general** warnings:



Indicates an imminently hazardous situation which, if not avoided, will result in serious injury or death.



Indicates a potentially hazardous situation which, if not avoided, could result in serious injury or death.



Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury or property damage.

The following safety signs indicate **specific** warnings or prohibited actions, or indicate a mandatory action:



Alerts the user to a specific hazardous situation. The given example means “To warn of electricity”.



Prohibits a specific action. The given example means “Do not touch”.



Specifies a mandatory action. The given example means “Connect an earth to the ground”.

CONVENTIONS USED IN THIS MANUAL

Types of Notes

The following types of **notes** are used in this manual to help the operator obtain reliable measurement data through correct instrument operation.

IMPORTANT An important note provides information essential to use the product. You cannot disregard this note.

An important note is a type of precaution, which if neglected could result in degraded performance or accuracy, or instrument malfunction/failure.

NOTE A note provides information to be especially noted or supplemented to use the product. A note also supplies information to be noted for specific operations (e.g., memory limitation, instrument configuration, or details that apply to specific versions of a program).

TIP A tip is a type of note that helps the user to apply the operation method and procedures to his or her specific conditions.

A tip also indicates the reference destination if there is information to be referred to.

The specifications and information in this manual are subject to change without notice.

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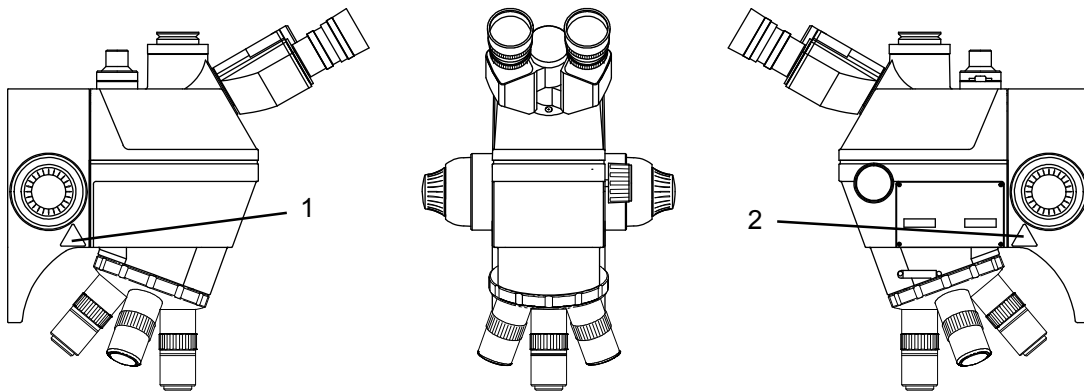
Labels on Product

Product Safety Labels


This measuring instrument has been designed and manufactured with human safety taken as a major consideration. Additionally, in order to use it more safely, Product Safety Labels have been applied to the main unit and all peripheral devices. This section describes the label application places and warning information at each place.

Before operating the measuring instrument, be sure to carefully read this section to use it safely for an extended period of service life.

■ Main unit



<Product Safety Labels>

| | | |
|-----|---|--|
| 1,2 |  | <p>Warning; Crushing of Hands (Prevents the operator from the risk of injury due to pinched fingers.)</p> <p>When the optical tube moves in the Z-axis direction, there is a risk that your hands could be pinched between the optical tube unit and the focus unit. Absolutely do not place hands between them.</p> |
|-----|---|--|

Precautions for Use

When using FS70series microscope with a laser unit installed, observe the following safety points.



- 1) The FS70 microscope supports UV (266nm), near UV (355nm), visible (532nm) and near IR (1064nm) wavelengths (355nm, 532nm, and 1064nm for the FS70L, and 266nm and 532nm for the FS70L4). Do not use any other wavelengths.
 - 2) Blindness can result if the laser light contacts the naked eye. Never look at the laser light directly. Caution is required since this unit supports the UV (266nm), near UV (355nm) and near IR (1064nm) wavelengths, which are invisible.
 - 3) When the laser unit is operating, always wear protective goggles designed for lasers.
 - 4) When the laser is operating, never look into the inside of the main unit through the eyepiece, the binocular block the eyepiece removed or the TV camera mounting position in the TV port.
 - 5) Laser light reflected or scattered from processed workpiece is also dangerous. Do not look at processed workpiece directly when the laser is operating. Install an appropriate shield around processed workpiece.
-

Installation Environments

To ensure the best performance and safety from the precision optical instruments in this series, install them in an environment that meets the following conditions.

1. Vibrations

IMPORTANT Install this instrument in an area with as few vibrations as possible. If used for extended periods in an area of high vibrations, problems may develop in precision components, and observation performance may deteriorate. If the instrument must be used in a high-vibration level environment, install a vibration isolating stand or take other measures to reduce the vibration level.

2. Dust

IMPORTANT Dust in the environment can adversely influence the microscope's internal optical components, objective, eyepiece, and electronic components in the fiber-optic illuminator. Install the equipment in an area with as little dust as possible.

3. Ambient light

IMPORTANT If sunlight strikes the instrument directly, the heat can warp or deform the main section, lowering observation performance. If the instrument must be installed near a window, be sure to block the sunlight with shades or blinds.

4. Ambient temperature and humidity

IMPORTANT Avoid using the instrument in areas where there are rapid changes in temperature and humidity, to prevent lowering the observation performance. The instrument is designed for optimum performance at 20°C. We strongly recommend using this instrument at 20°C neighborhood.

Warranty

In the event that this product should prove defective in workmanship or material, within one year from the date of original purchase for use, it will be repaired or replaced, at Mitutoyo's option, free of charge upon its prepaid return to Mitutoyo, without prejudice to the provisions of the Mitutoyo Software End User License Agreement.

If this product fails or is damaged for any of the following reasons, it will be subject to a repair charge, even if it is still under warranty.

- (a) Failure or damage owing to fair wear and tear.
- (b) Failure or damage owing to inappropriate handling, maintenance or repair, or to unauthorized modification.
- (c) Failure or damage owing to transport, dropping, or relocation of the instrument after purchase.
- (d) Failure or damage owing to fire, salt, gas, abnormal voltage, lightning surge, or natural disaster.
- (e) Failure or damage owing to use in combination with hardware or software other than those designated or permitted by Mitutoyo.
- (f) Failure or damage owing to use in ultra-hazardous activities.

This warranty is effective only where the instrument is properly installed and operated in conformance with the instructions in this manual within the original country of the installation.

EXCEPT AS SPECIFIED IN THIS WARRANTY, ALL EXPRESS OR IMPLIED CONDITIONS, REPRESENTATIONS, AND WARRANTIES OF ANY NATURE WHATSOEVER INCLUDING, WITHOUT LIMITATION, ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, NONINFRINGEMENT OR WARRANTY ARISING FROM A COURSE OF DEALING, USAGE, OR TRADE PRACTICE, ARE HEREBY EXCLUDED TO THE MAXIMUM EXTENT ALLOWED BY APPLICABLE LAW.

You assume all responsibility for all results arising out of its selection of this product to achieve its intended results.

Disclaimer

IN NO EVENT WILL MITUTOYO, ITS AFFILIATED AND RELATED COMPANIES AND SUPPLIERS BE LIABLE FOR ANY LOST REVENUE, PROFIT, OR DATA, OR FOR SPECIAL, DIRECT, INDIRECT, CONSEQUENTIAL, INCIDENTAL, OR PUNITIVE DAMAGES HOWEVER CAUSED AND REGARDLESS OF THE THEORY OF LIABILITY ARISING OUT OF THE USE OF OR INABILITY TO USE THIS PRODUCT EVEN IF MITUTOYO OR ITS AFFILIATED AND RELATED COMPANIES AND/OR SUPPLIERS HAVE BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

If, notwithstanding the foregoing, Mitutoyo is found to be liable to you for any damage or loss which arises out of or is in any way connected with use of this product by you, in no event shall Mitutoyo's and/or its affiliated and related companies' and suppliers' liability to you, whether in contract, tort (including negligence), or otherwise, exceed the price paid by you for the product only.

The foregoing limitations shall apply even if the above-stated warranty fails of its essential purpose.

BECAUSE SOME COUNTRIES, STATES OR JURISDICTIONS DO NOT ALLOW THE EXCLUSION OR THE LIMITATION OF LIABILITY FOR CONSEQUENTIAL OR INCIDENTAL DAMAGES, IN SUCH COUNTRIES, STATES OR JURISDICTIONS, MITUTOYO'S LIABILITY SHALL BE LIMITED TO THE EXTENT PERMITTED BY LAW.

Export Control Compliance

This Product falls into the Catch-All-Controlled Goods and/or Catch-All-Controlled Technologies (including Programs) under Category 16 of Appended Table 1 of Export Trade Control Order or under Category 16 of Appended Table of Foreign Exchange Control Order, based on Foreign Exchange and Foreign Trade Law of Japan.

If you intend re-exporting the product from a country other than Japan, re-selling the product in a country other than Japan, or re-providing the technology (including program), you shall observe the regulations of your country.

Notes on Export to EU Member Countries

When you intend exporting this product to any of the EU member countries, it may be required to provide User's Manual(s) in English and EU Declaration of Conformity in English (under certain circumstances, User's Manual(s) in the destination country's official language and EU Declaration of Conformity in the destination country's official language). For detailed information, please contact Mitutoyo in advance.

CONTENTS

| | |
|---|------------|
| CONVENTIONS USED IN THIS MANUAL..... | i |
| Labels on Product | iii |
| Precautions for Use..... | iv |
| Installation Environments..... | v |
| Warranty | vi |
| Disclaimer | vii |
| Export Control Compliance | viii |
| Notes on Export to EU Member Countries..... | viii |
| 1 Overview | 1-1 |
| 1.1 Outline | 1-1 |
| 1.2 System Configuration | 1-1 |
| 1.2.1 System Appearance | 1-1 |
| 1.2.2 System Configuration | 1-2 |
| 1.3 Nomenclature and Functions of Each Part..... | 1-4 |
| 1.3.1 Microscope unit | 1-4 |
| 1.3.2 Fiber-optic illuminator unit | 1-6 |
| 2 Setup | 2-1 |
| 2.1 Unpacking and Checking | 2-1 |
| 2.2 Assembly and Adjustment Procedures | 2-1 |
| 2.2.1 Assembling | 2-1 |
| 2.2.2 Attaching a revolver | 2-2 |
| 2.2.3 Attaching objectives..... | 2-3 |
| 2.2.4 Attaching the eyepiece..... | 2-3 |
| 2.2.5 Turning on power to the fiber-optic illuminator and adjusting the bulb brightness | 2-3 |
| 2.2.6 Centering the aperture diaphragm..... | 2-4 |
| 2.2.7 Mounting a CCD camera | 2-5 |
| 2.2.8 Adjusting the camera focal plane position | 2-6 |
| 2.2.9 Mounting the laser unit | 2-7 |
| 2.2.10 Adjustments for the user | 2-8 |
| 3 Operation | 3-1 |
| 3.1 Focusing..... | 3-1 |
| 3.2 Zooming (Changing the Tube Magnification)..... | 3-1 |
| 3.3 Switching the Optical Path | 3-2 |
| 3.4 Switching the GIF Filter | 3-2 |
| 3.5 Using the Filters | 3-3 |
| 3.6 Polarized Light Observation | 3-4 |

| | | |
|-------|---|------|
| 3.7 | Differential Interference Contrast (DIC) Observation | 3-5 |
| 3.8 | Operating the Tilting Head..... | 3-6 |
| 3.8.1 | Adjusting the Observation Height (Angle) of the Binocular Unit..... | 3-6 |
| 3.8.2 | Switching the Optical Path..... | 3-6 |
| 4 | Maintenance and Inspection | 4-1 |
| 4.1 | Daily Maintenance | 4-1 |
| 4.1.1 | Cleaning optical components | 4-1 |
| 4.1.2 | Cleaning metal parts | 4-1 |
| 4.1.3 | Storage..... | 4-1 |
| 4.2 | Periodic Inspections | 4-2 |
| 4.3 | Replacing the Bulb | 4-2 |
| 5 | Troubleshooting | 5-1 |
| 5.1 | Problems with the Observed | 5-1 |
| 5.2 | Problems During Operation..... | 5-2 |
| 5.3 | Electrical Problems | 5-2 |
| 6 | Specifications | 6-1 |
| 6.1 | Microscope Unit..... | 6-1 |
| 6.2 | Laser Port..... | 6-2 |
| 6.3 | Standard Accessories | 6-2 |
| 6.4 | Optional Accessories | 6-3 |
| 6.5 | Objectives, Tube Lens, Eyepieces Specification Table | 6-6 |
| 6.6 | Layout of the Optical System | 6-8 |
| 6.7 | External Dimensions | 6-12 |

SERVICE NETWORK

1

Overview

This section lists the various FS70 microscope unit, and names and functions of parts. Note that this manual applies to various FS70.

1.1 Outline

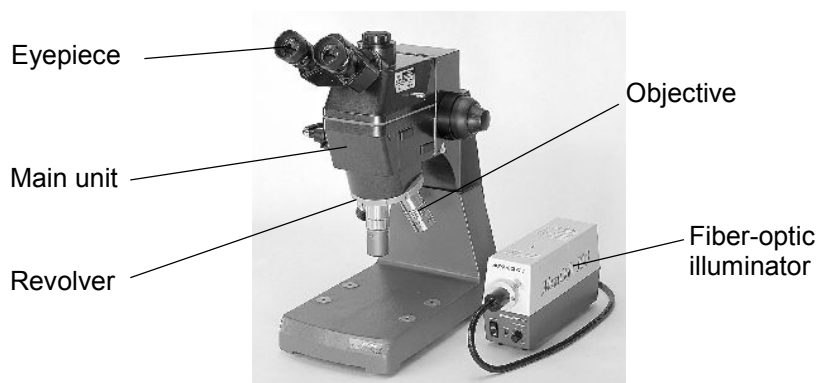
The Mitutoyo FS70 Series products are microscope units designed to be installed in defect analysis probes and other equipment. This unit provides the following features:

- Optimal characteristics for inspecting precision-manufactured parts, such as semiconductor wafers and magnetic heads.
- The optical system uses easy-to-use ultra-long working distance objectives and eyepieces with wide field of view.
- The FS70 series offers high operability for a microscope with a long working distance that features Mitutoyo objectives by tilting the revolver inward.
- With the revolver four objectives can be switched.
- The Microscope with laser mount type supports four wavelengths (1064, 532, 355, and 266nm).
- A contamination-resistant structure is implemented for each operating unit.
- An extensive line of accessories that can expand the range of applications even further. (See Section 6.4, "Optional accessories".)

1.2 System Configuration

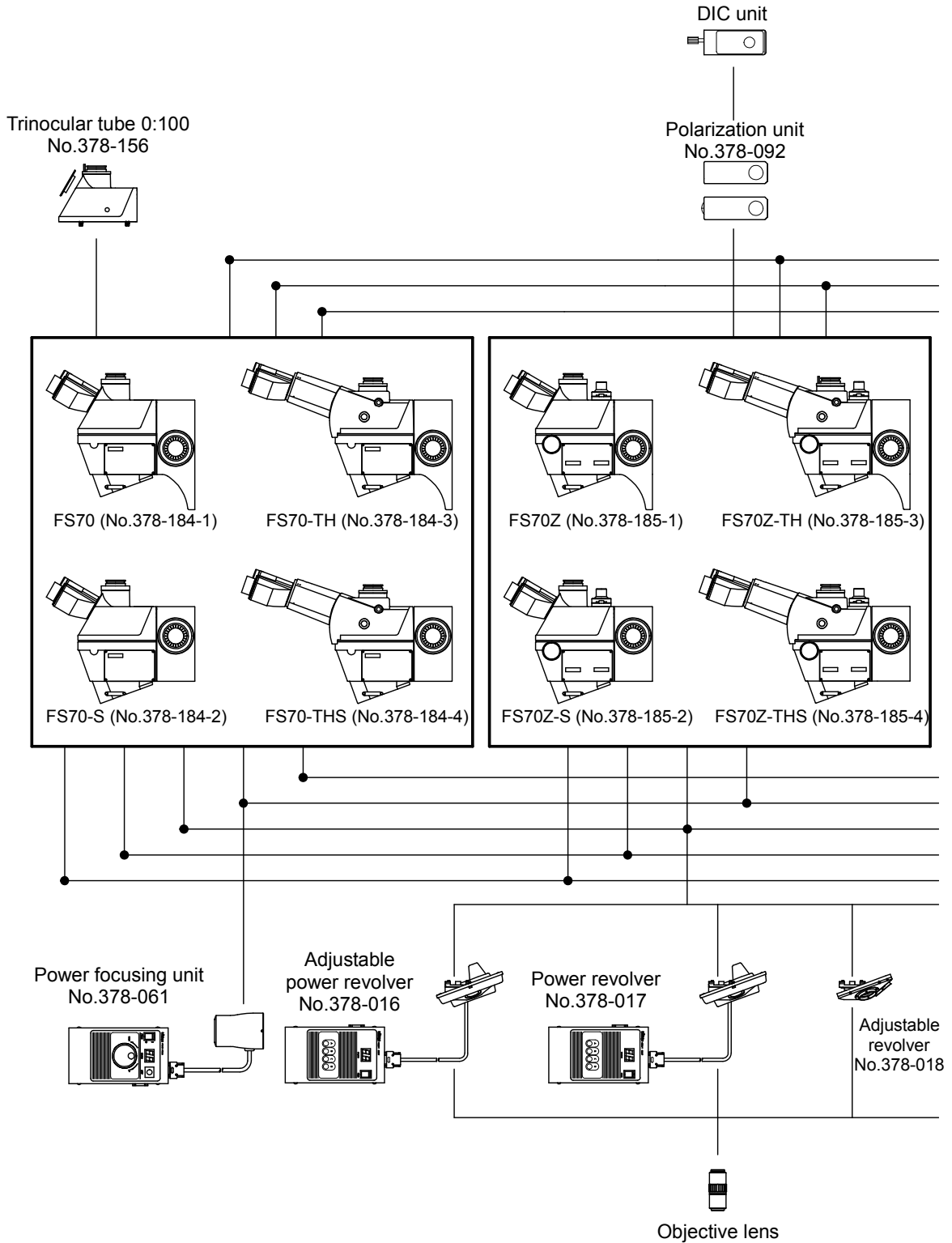
The FS70 microscope unit consists of the main unit as basic model and optional accessories such as eyepieces, objectives, illuminator and peripheral equipment.

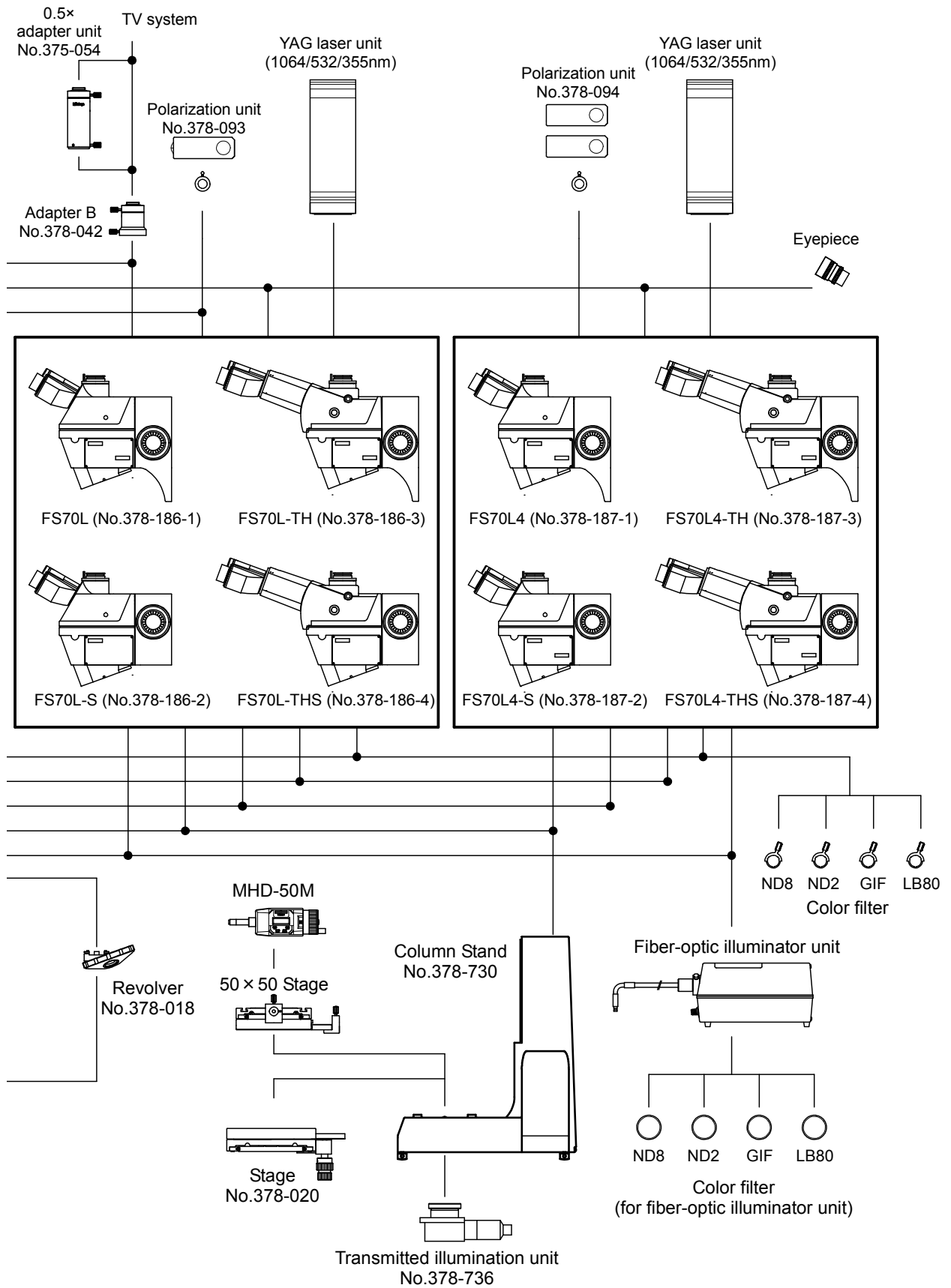
1.2.1 System Appearance



1.2.2 System Configuration

The system of each series consists of the following units.



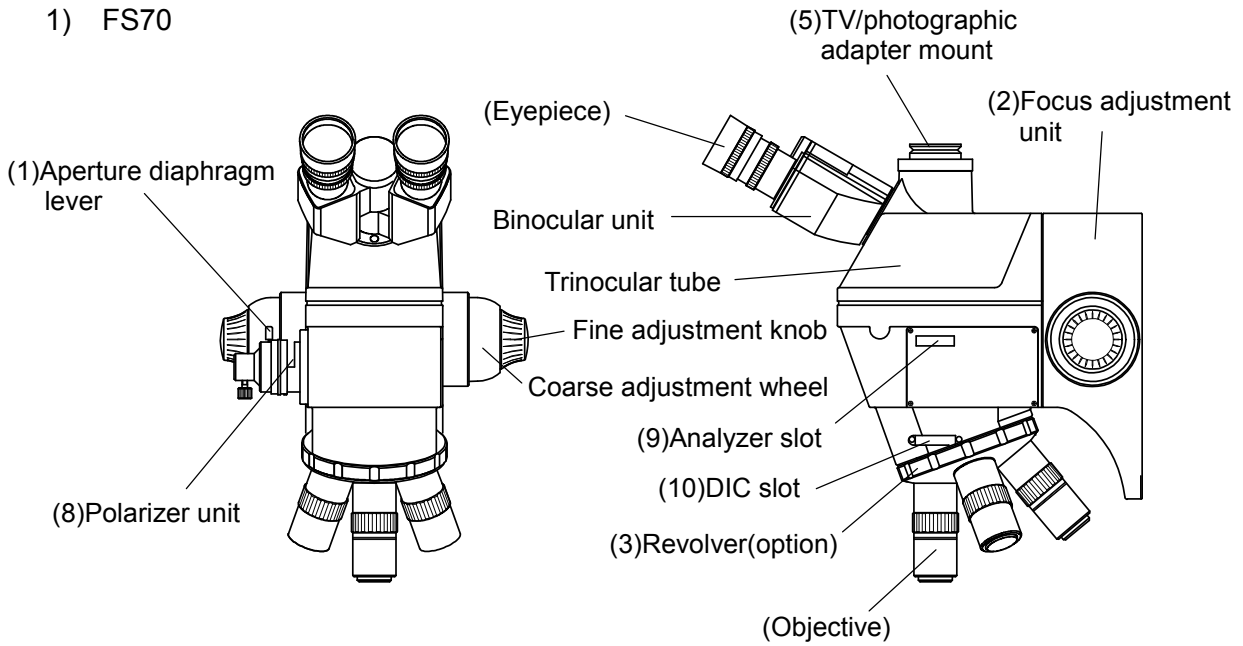


1.3 Nomenclature and Function of Each Part

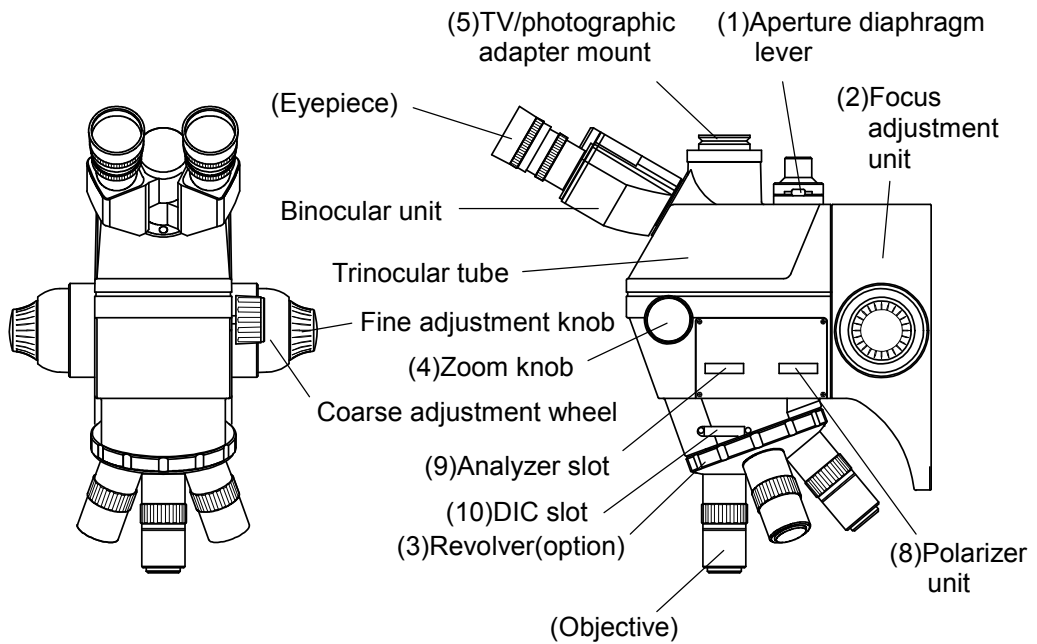
This section describes the name and function of each part.

1.3.1 Microscope unit

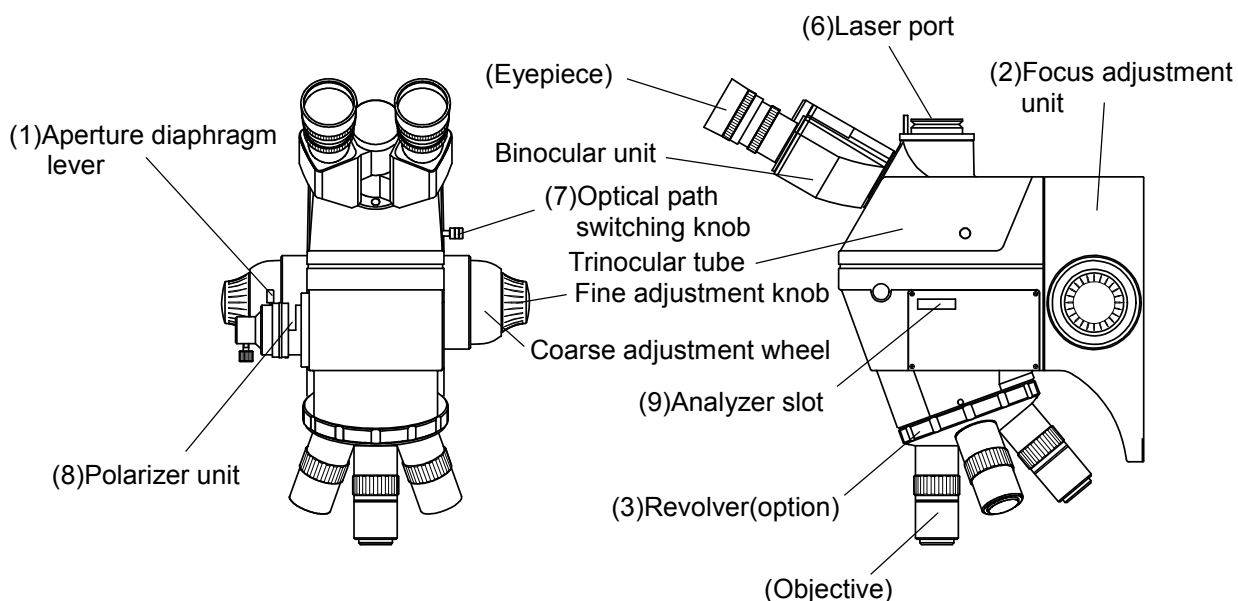
1) FS70



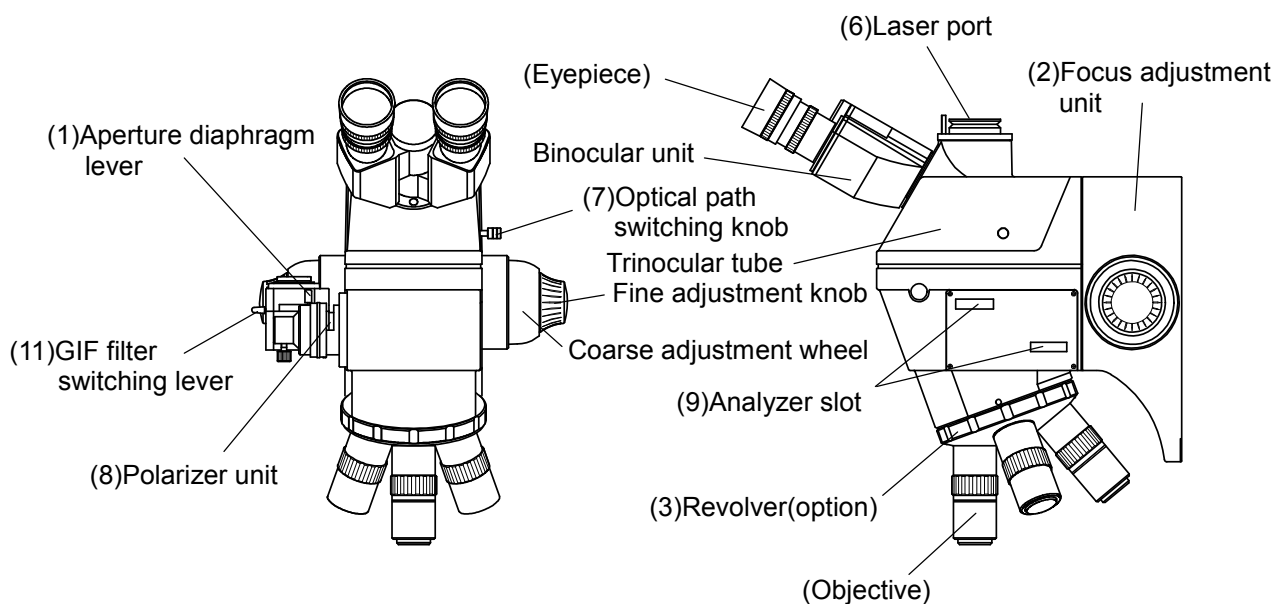
2) FS70Z



3) FS70L



4) FS70L4



(1) Aperture diaphragm lever:

Adjusts the numerical aperture of the illumination system.
Pull this lever forwards to increase the diameter of the aperture diaphragm.

(2) Focus adjustment unit:

Moves the microscope unit up and down.

(3) Revolver (Optional accessory) · · · See the following caution:

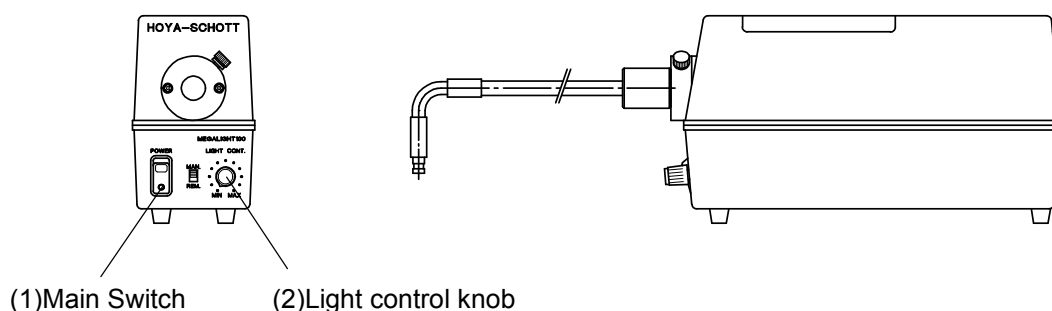
Used to switch a desired objective. Allows a maximum of four bright-field objectives between 1X and 200X to be mounted. Power revolver and adjustable revolver, etc. are available as options. Selects according to the application.

-
- (4) Zoom knob:**
Increases the magnification continuously from 1× to 2× by turning this knob counterclockwise (Available for FS70Z).
 - (5) TV/photographic adapter mount:**
Used to attach the TV camera or photographic unit. (Available for FS70 and FS70Z.)
 - (6) Laser port:**
Used to mount a small laser unit for microscopes on the laser mount.
A pin for safety interlock release is provided on the mount part.
(Available for FS70L and FS70L4.)
 - (7) Optical path switching knob:**
Pushes this knob in (the unit) to use as a binocular unit; pulls it out to permit laser processing or observation on the TV monitor. (Available for FS70L and FS70L4.)
 - (8) Polarizer slot:**
Slot for inserting a polarizer. The polarizing direction is fixed in the case of FS70, FS70Z and FS70L and can be rotated up to 180° in the case of FS70L4.
 - (9) Analyzer slot:**
Slot for inserting an analyzer. The polarizing direction of the analyzer can be rotated up to 360° in the case of FS70, FS70Z and FS70L and is fixed in the case of FS70L4.
 - (10) DIC (differential interference contrast) slot:**
Slot for inserting a DIC unit. (Available for FS70 and FS70Z.)
 - (11) GIF filter switching lever:**
Lever for switching to the green filter when using the UV objectives.
(Available for FS70L4)



Fingers might be pinched if the revolver is rotated toward the focus unit side (rearward). If the objective is required to be switched, rotate the revolver frontward. If holding the revolver with your right hand, turn it clockwise; if holding the revolver with your left hand, turn it counterclockwise.

1.3.2 Fiber-optic illuminator unit (Optional accessory)



- (1) Main Switch:**
Turns the illuminator power ON or OFF.
- (2) Light control knob:**
Adjusts the brightness of the illuminator.

2

Setup

This chapter describes the procedures for connecting and adjusting the components of the FS70 microscope unit.

2.1 Unpacking and Checking

Prior to shipment from the factory, the FS70 is thoroughly inspected and its mechanical, optical, and electrical operation are fully guaranteed.

Unpack the FS70, and make sure that all accessories and components are present, and that the FS70 was not damaged during shipment. If you have any questions, contact your dealer or nearest Mitutoyo Service Center.

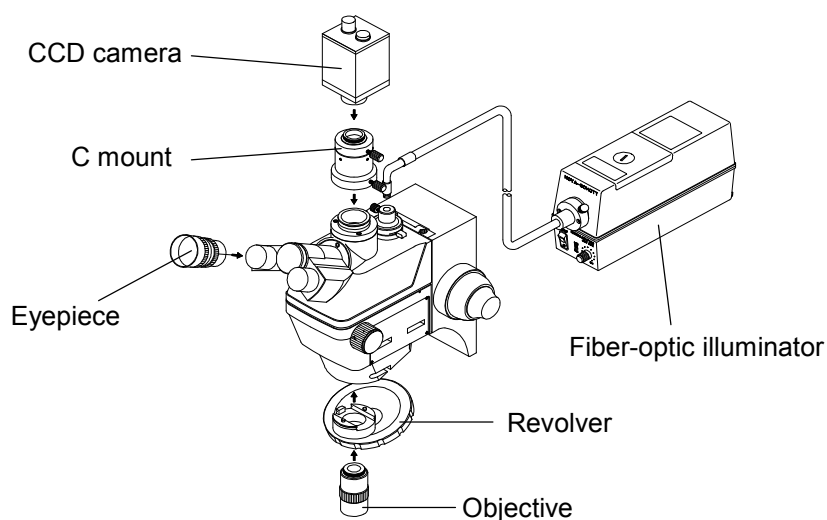
2.2 Assembly and Adjustment Procedures

Before using the FS70, assemble the microscope unit and check each function according to sections 2.2.1 through 2.2.10.

Adjust only the parts that require adjustment.

2.2.1 Assembling

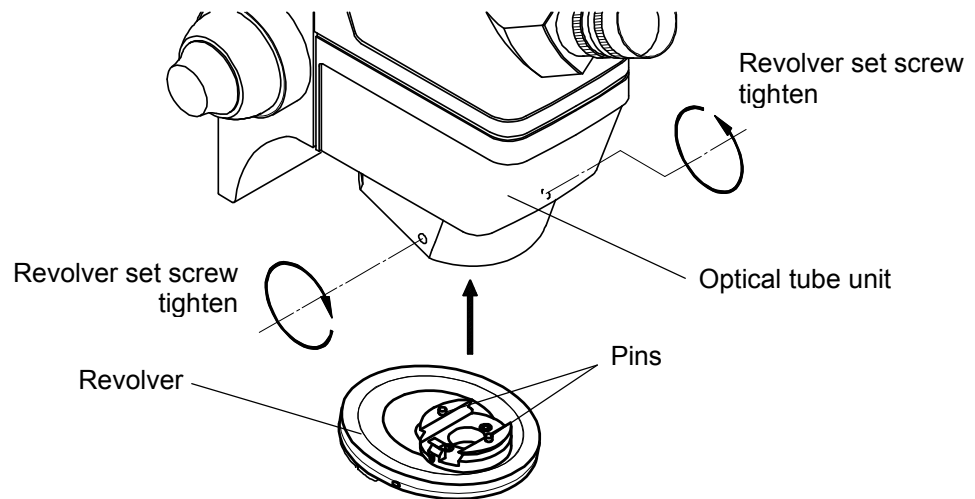
Mount the microscope unit on an instrument, such as a prober station, or on a stand and install a revolver, lenses, a camera, a laser unit, etc.



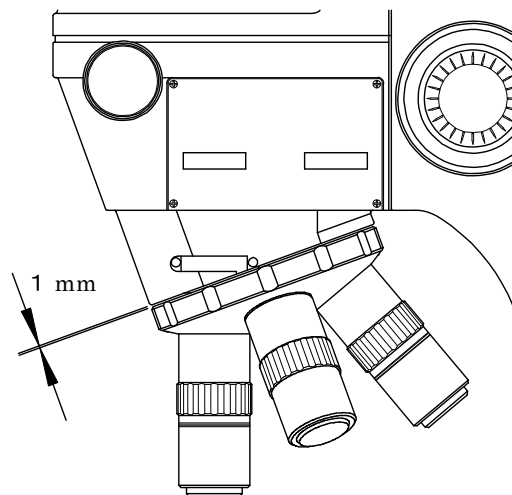
2.2.2 Attaching a revolver

Attach the optional revolver to the optical tube unit according to the following procedure.

- 1) While securely holding the revolver, mate the two pins with the holes on the optical tube side, and then push the revolver upward.
- 2) Insert the Allen wrench (nominal 1.5mm) into the holes on both sides of the optical tube unit to tighten the screws (2 pieces) that secure the revolver firmly while holding the revolver by hand.



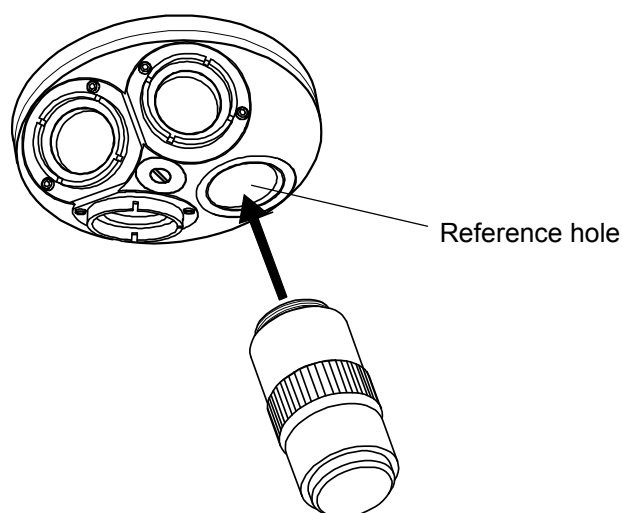
1. There is a risk in which the revolver drops at switching and mounting/dismounting an objective, etc., when the revolver is not securely fixed to the back. Mount the revolver correctly to the optical tube unit so that the clearance becomes as shown in the figure below, then fix it with the screws securely.



2. Hold the revolver by hand when loosening the screws that secure the revolver. If the screws are loosened and the revolver is not held, the revolver may drop, possibly damaging the instrument, or a workpiece.
-

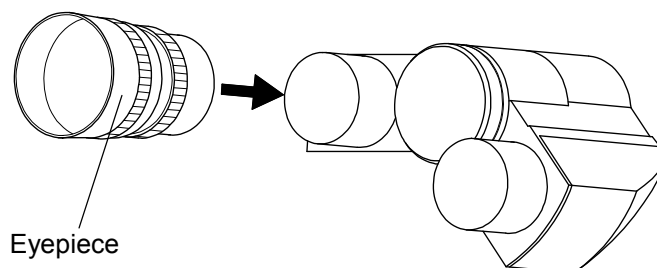
2.2.3 Attaching objectives

Remove the caps mounted on the revolver, then attach the objectives by screwing them onto the revolver. A maximum of 4 objectives can be attached. In the case of the revolver with aligning mechanism, be sure to attach the highest magnification lens of the objectives to be used to the reference hole with no aligning mechanism.



2.2.4 Attaching the eyepieces

Remove the caps mounted on the binocular unit, then attach the eyepieces by inserting them into the unit.



2.2.5 Turning on power to the fiber-optic illuminator and adjusting the bulb brightness

Check whether the power to the illuminator can be turned on and the brightness can be adjusted. Next, adjust the Light control knob so that the bulb brightness is optimal. For detailed information, refer to the “Fiber-optic Illuminator” user’s manual.



The temperature in the vicinity of the illuminator unit becomes very hot. Keep flammable objects and your hands clear.

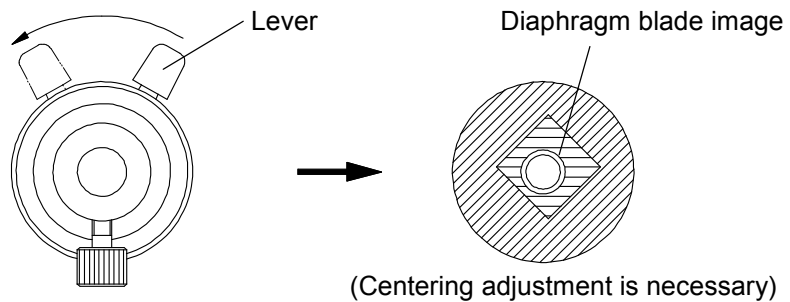
TIP For information about replacing the tungsten-halogen bulb, refer to the “Fiber-optic Illuminator” user’s manual.

2.2.6 Centering the aperture diaphragm

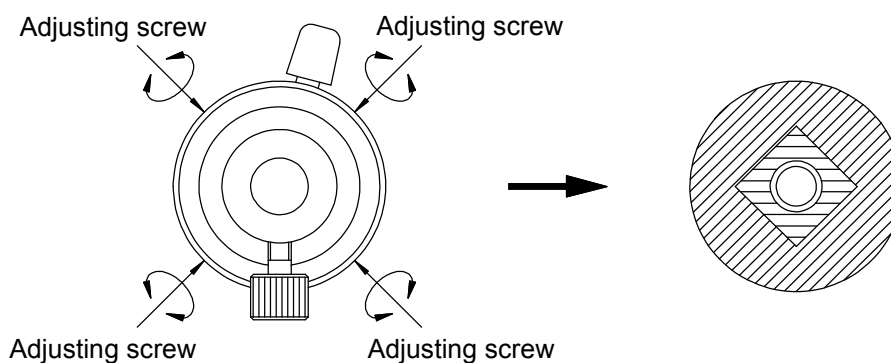
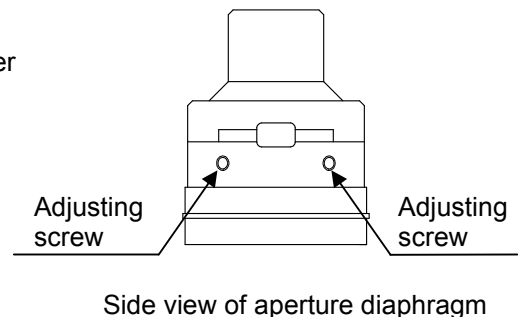
The aperture diaphragm has been factory-adjusted so that the center of the diaphragm coincides with that of the illumination light path or the field of view.

If the diaphragm is off-center as shown below and readjustment is necessary, adjust it according to the following procedure.

- 1) Pull off one of the eyepieces, and then look into the optical tube.
- 2) Move the aperture diaphragm lever all the way rearward to minimize the diameter of the diaphragm.



- 3) Adjust the diaphragm position by turning the adjusting screws (four pieces) so that the diaphragm blade image comes to the center of the optical tube.
- 4) Return the aperture diaphragm lever to the optimal position.



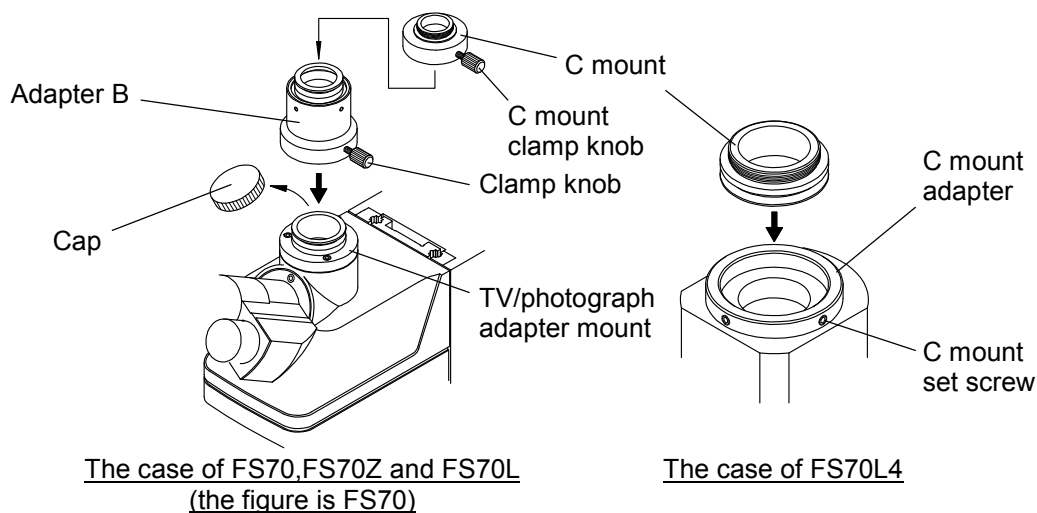
TIP The aperture diaphragm function is valid for objectives with magnifications of 20X or less. Objectives with magnifications of 50X or more have the effect of reducing the flare on an observation image.

2.2.7 Mounting a CCD camera

This section gives the procedure for mounting a CCD camera the user has prepared on the microscope. In order to make optimum use of a CCD camera after mounting it, adjustment may be required depending on the camera to be used. The adjusting procedure is given in the next section, 2.2.8.

(1) The case of FS70, FS70Z and FS70L

- 1) Prepare an Adapter B (optional accessory).
- 2) Unfasten a C-mount clamp knob (one piece) on the Adapter B to remove a C mount.
- 3) Attach the C mount to the CCD camera. Mount this assembled C mount on the Adapter B again, then clamp the C mount securely with the C-mount clamp knob.
- 4) Remove the cap on the TV/photograph adapter mount.
- 5) Mount the Adapter B, to which the CCD camera was attached, on the TV/photograph adapter mount, then orient the camera frontward. (Display the camera output on the monitor as required to check the picture orientation.)
- 6) Clamp the Adapter B securely with the clamp knob (one piece).



TIP If mounting the CCD camera on the FS70L without attaching the laser unit, remove the pin for safety interlock release on the mount beforehand with the supplied Allen wrench (nominal 1.5mm).

(2) The case of FS70L4

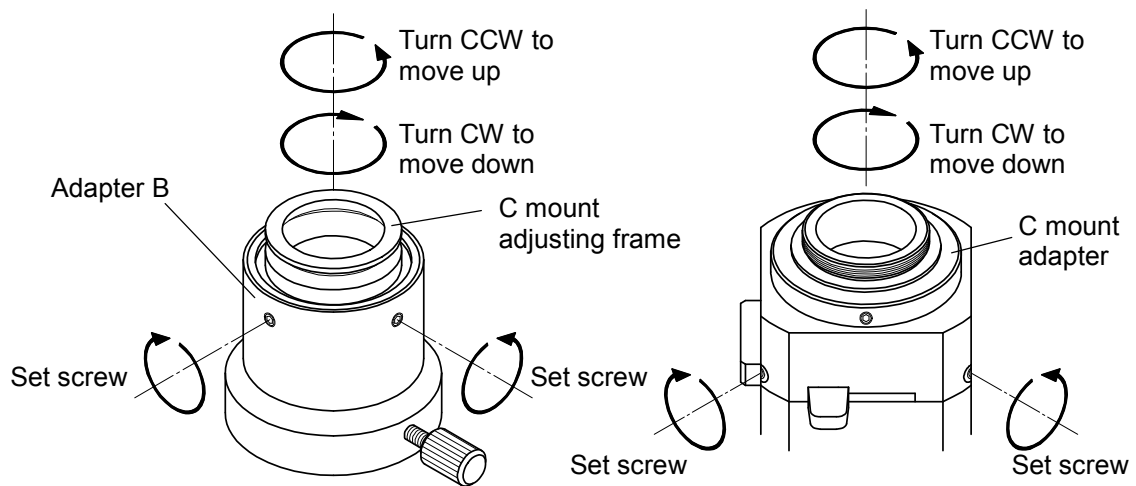
- 1) Loosen the two C-mount set screws securing the C mount (using the Allen wrench, nominal 1.5mm), then remove the C mount.
- 2) Screw the C mount tightly onto the CCD camera to be used.
- 3) Mount the C mount, to which the camera was attached, on the C-mount adapter again. Tighten the C-mount set screws loosened in step 1 to secure the C mount.

TIP To change the orientation of an observation image at monitor observation, loosen the C-mount set screw and then rotate the camera together with the C mount.

2.2.8 Adjusting the camera focal plane position

Adjust the camera mounting position in the optical axis direction so that the focus will not change significantly when the magnification is changed. Check the focal plane position according to the following procedure and adjust it if necessary.

- 1) While looking into the eyepiece bring the index dot used as a reference into the center of the field of view.
- 2) After maximizing the magnification, focus on the index dot by moving the microscope unit up and down.
- 3) Minimize the magnification.
- 4) If a picture on the TV monitor is out of focus, dismount the C mount to which the CCD camera was attached.
- 5) Loosen the three set screws on the side of Adapter B (using the Allen wrench, nominal 1.5mm), and then rotate the C mount adjusting frame to adjust its mounting position so that the picture on the monitor is in focus.
For the FS70L4 loosen the two set screws on the side of the mount for the C mount adapter, then adjust the C mount position in the same way as above.
- 6) Replace the C mount. Set the maximum magnification, then check that the picture on the monitor is in focus.
- 7) If the picture is still not in focus, repeat steps 2) to 6) to adjust the C mount adjusting frame so that the focus deviation between the maximum and minimum magnifications is minimized.



The case of FS70,FS70Z and FS70L

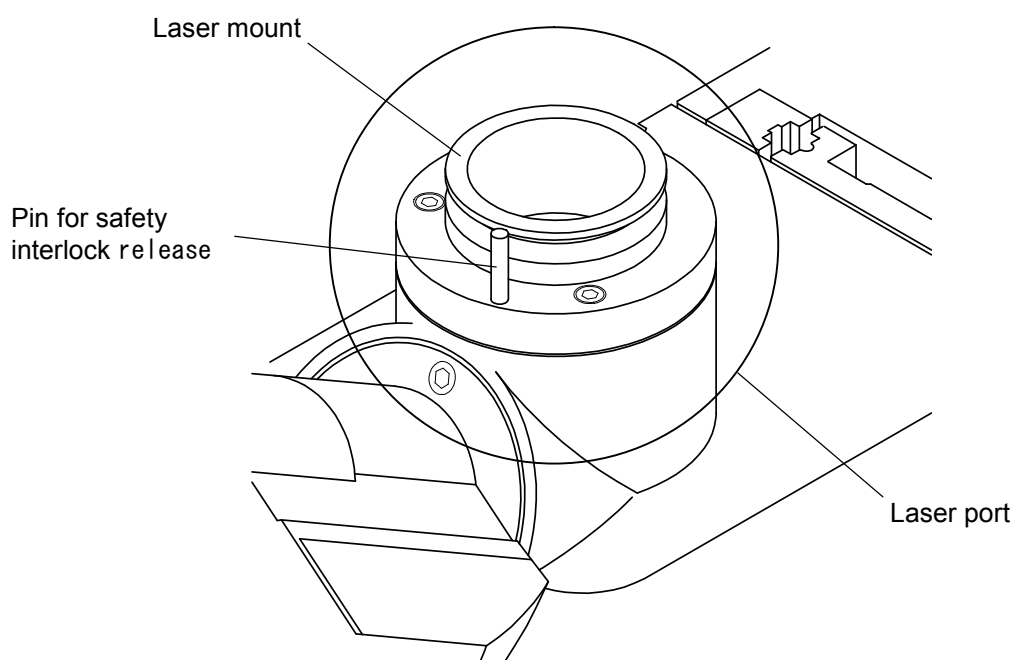
The case of FS70L4

2.2.9 Mounting the laser unit

This section gives the procedure for positioning the laser unit at the laser port and mounting it on the laser mount.

- 1) Position the safety interlock release button on the laser unit to the pin for safety interlock release on the laser port, then mount the laser unit on the laser mount.
- 2) Tighten the set screws on the mount to secure the laser unit in place.

For detailed information, refer to the laser unit user's manual.



- Before mounting the laser unit on the microscope be sure to read “Handling precautions, 2. Laser unit” (page iii) in this manual.
- Turn off the power to the laser unit when dismantling the laser unit.
- The laser wavelengths used with this microscope are 355nm, 532nm, and 1064nm for the FS70L, and 266nm and 532nm for the FS70L4.
- Exercise care when using the laser unit so as not to exceed the upper limit of laser input indicated in section 6.2, “Laser Port”.

2.2.10 Adjustments for the user

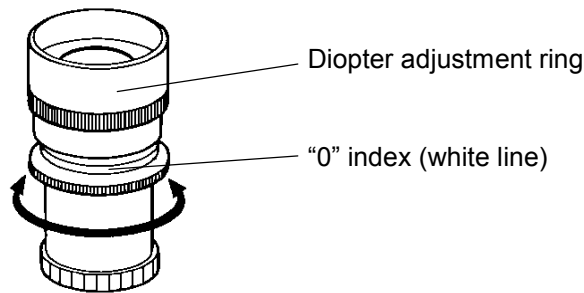
The pupil distance, diopter, and optimum brightness may differ from user to user. Before using the microscope every time, the user must make adjustments according to the following procedure.

(1) Diopter adjustment

Adjust the diopter of the eyepiece as follows.

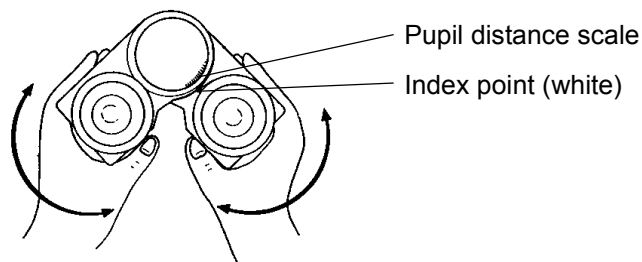
- 1) Turn the diopter adjustment ring of the eyepiece until the lower edge of the ring is aligned with the "0" index line (white). Align both eyepieces.
- 2) Change the objective to one with a smaller magnification.
- 3) Following the instructions described in Section 3.1, "Focusing", focus the workpiece.
- 4) Turn the diopter adjustment ring to obtain the sharpest image for each eye, without turning the focusing handles.

※The diopter correction range for each eyepiece is -8D to +4D.



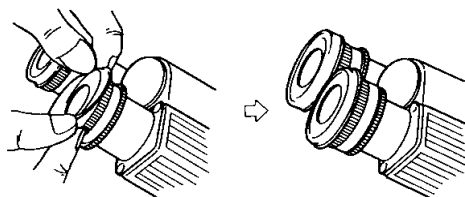
(2) Pupil distance adjustment

While looking into the eyepieces and holding the binocular head with both hands, move the tubes in the direction of the arrows (see the diagram below) until the both fields of view coincide. (The pupil adjustment range is between 51 and 76 mm.)



TIP The 10X eyepiece uses a high-eye-point system and has rubber eye cups attached.

If you wear eyeglasses, turn the rims outward, as shown in the diagram below.



3

Operation

This chapter gives the procedure for operating the microscope for specific purposes.

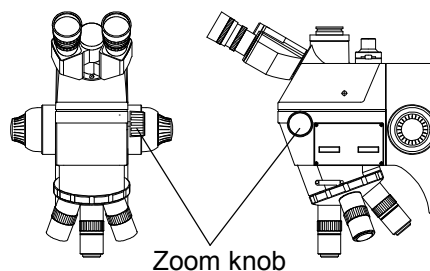
3.1 Focusing


- 1) Turn the revolver and select the objective with the minimum magnification.
- 2) Turn the coarse adjustment wheel on the focus unit to move the microscope unit up and down, and visually set the distance between a workpiece and the objective mount on the revolver to approximately 95mm.
- 3) Turn the fine adjustment knob to focus on the workpiece.
- 4) Gradually increase the magnification of the objective, then focus on the workpiece by turning the fine adjustment knob.
- 5) When the desired magnification observation range is obtained, finely focus on the workpiece.


TIP Of high-magnification, high-NA objectives (optional), some objectives have a relatively short working distance. If these objectives are used, be careful so as not to bump the lens tip against the workpiece. To prevent damage to an objective, first move the microscope unit down to a position that is a little shorter than the working distance while watching the gap between the lens tip and the workpiece. Next focus on the workpiece by moving the microscope unit upward. Use this procedure to perform focusing safely.

3.2 Zooming (Changing the Tube Magnification) (Available only for FS70Z)

The FS70Z incorporates a zoom mechanism that magnifies an observation image up to 2 times. Operate the knob as illustrated in the figure.



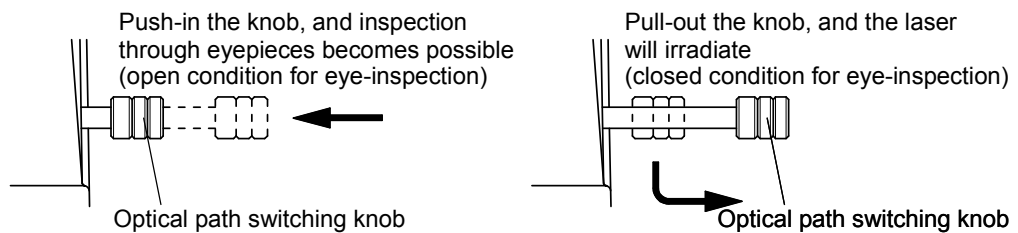
Turn the knob clockwise to minimize the image (at least 1×). 

Turn the knob clockwise to maximize the image (at most 2×). 

3.3 Switching the Optical Path (Available for FS70L and FS70L4)

The laser support microscope units incorporate an optical path switching mechanism. The transmission ratio between the binocular observation optical path and the laser optical path can be switched to 100%:0% or 0%:100%.

To switch between the optical paths, use the optical path switching knob on the right side of the microscope unit. For safety, the binocular unit incorporates laser-protective filters for wavelengths of 266, 355, 532, and 1064nm.



WARNING

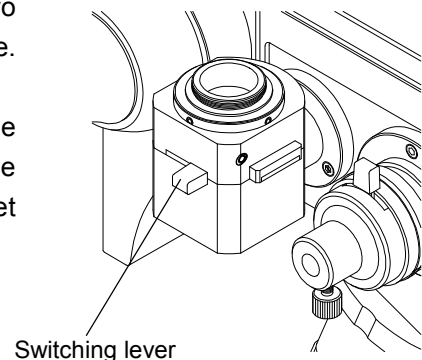
1. When performing laser processing pull the optical path switching knob all the way out to the end of its stroke.
2. Never remove the laser-protective filters.
3. Under no circumstances look into the eyepieces or the binocular unit from which eyepieces have been removed during laser oscillation.

TIP

The protection filter cuts the light around 532nm in the visible region. Therefore the green light is cut, the observation image becomes pinkish.

3.4 Switching the GIF Filter (Available only for FS70L4)

The FS70L4 incorporates a filter frame that allows a green filter to be inserted into the optical path in the CCD camera. The filter frame is provided with two kinds of filter glasses: a green filter and a parallel plate. During normal observation the parallel plate is used by sliding the switching lever on the left side toward the front. The switching lever is slid toward the rear to select the green filter only if the ultra-violet objective (optional) is used.



Important

When performing laser processing with the UV objective, focus the laser beam on the observation image filtered by the green filter. Not doing so may make the image out of focus. For laser processing, be sure to use the green filter.

3.5 Using the Filters

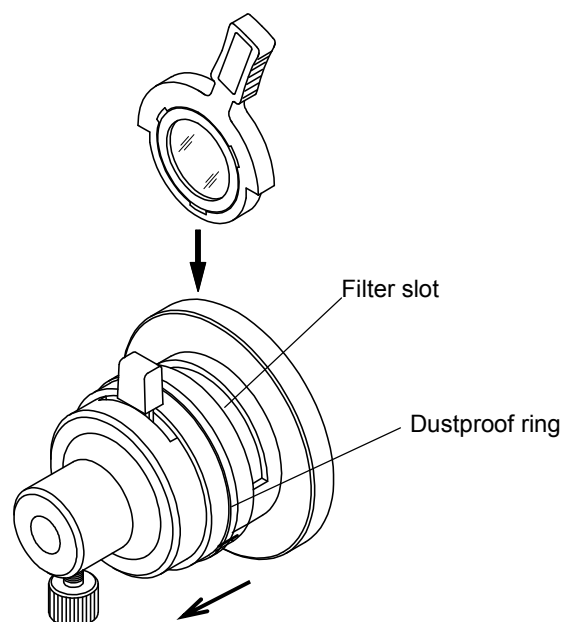
Various filters (optional) are available for the FS70 series. Select one appropriate to the purpose. Filters are used on the FS70, FS70L, and FS70L4 by attaching them to the fiber optic insertion unit on the left side of the microscope unit and the fiber-optic illuminator(optional). With the FS70Z a filter is attached only to the fiber-optic illuminator.

(1) Standard filter types and applications

| Name | Filter type | applications |
|-------------|-------------------------------------|---|
| LB80 | Color temperature conversion filter | General microscopic inspections or color microphotography |
| ND2 | Neutral filter (light) | General microscopic inspections or brightness control for color photography |
| ND8 | Neutral filter (dark) | |
| GIF | Green interference filter | Contrast adjustment |

(2) Attaching a filter for the microscope unit

Attach one of the filters to the slot of the fiber optic insertion unit by sliding the dustproof ring. For attaching filters to the FS70Z, refer to the "Fiber-optic Illuminator" user's manual.



The light source in the fiber optic illuminator becomes very hot during operation. When attaching a filter to the fiber optic illuminator do not touch anything in the vicinity of the light source unit with bare hands. Also, before detaching a filter wait until the light source unit has cooled sufficiently.

3.6 Polarized Light Observation

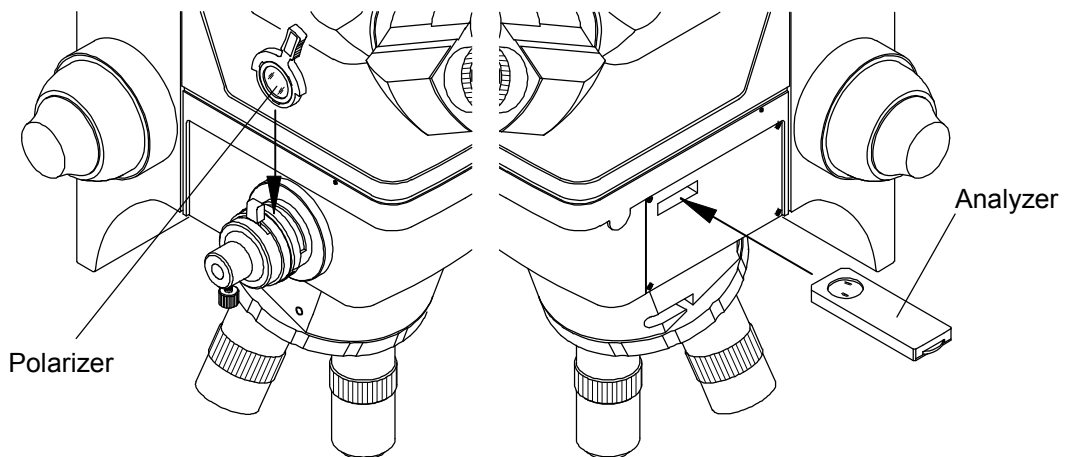
Polarized light observation which examines the peculiar optical property of workpiece is performed using the polarization unit (polarizer and analyzer) of optional accessory by following procedures.

(1) The case of FS70 and FS70L

Insert the polarizer all the way into the slot on the fiber optic insertion unit on the left side of the microscope unit, and insert the analyzer all the way into the slot on the right side of the microscope unit.

The analyzer can be rotated 360°.

If the polarizer is inserted, the brightness in the field of view is reduced even in the parallel Nicol state.

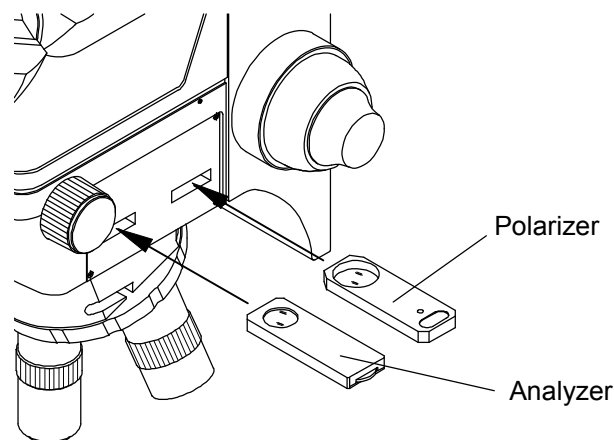


The case of FS70,FS70 (the figure is FS70)

(2) The case of FS70Z

Insert the polarizer all the way into the slot on the right rear side of the microscope unit, and insert the analyzer all the way into the slot on the front side.

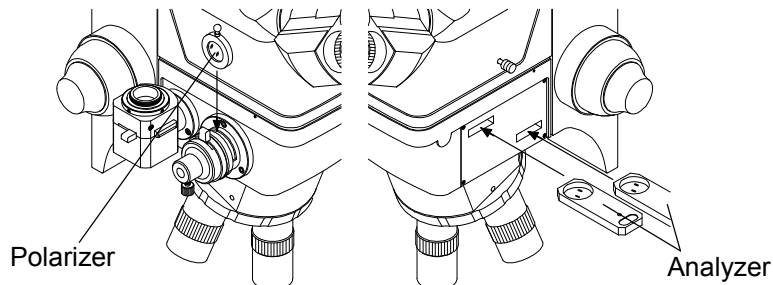
The analyzer can be rotated 360°.



(3) The case of FS70L4

Insert the polarizer all the way into the slot on the fiber optic insertion unit on the left side of the microscope unit, and insert the two analyzers all the way into the two slots on the right side of the microscope unit.

The polarizer can be rotated 180°.

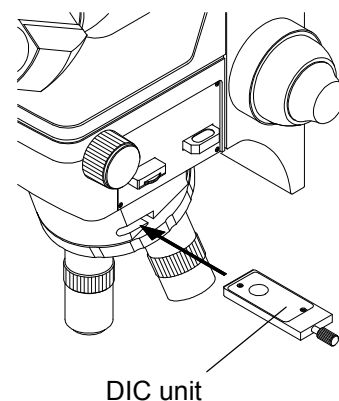


- Note**
1. Do not perform laser processing when the polarizer is inserted. Doing so may damage the polarizer.
 2. Adjust the brightness of an illuminator as required. Depending on the characteristic of a workpiece and the observation magnification, the brightness may be insufficient even at the maximum brightness setting.

3.7 Differential Interference Contrast (DIC) Observation (Available for FS70 and FS70Z)

The depth direction observation such as minute injury and step and ruggedness, etc. in the surface of workpiece is performed using polarization unit and differential interference contrast unit (DIC unit) of optional accessory by following procedures.

- 1) Set the polarizer and analyzer according to the procedure in section 3.6.
- 2) Prepare the objective and the illuminator, and then place a workpiece on the XY stage.
- 3) Focus on the workpiece surface by adjusting the coarse control wheel and the fine control knob.
- 4) Turn the analyzer knob so that the observation field of view (eyepiece inside or monitor screen) is as dark as possible.
- 5) Insert the DIC unit applicable for the objective being used into the DIC slot on the right side of the main unit.
- 6) Turn the knob on the DIC unit to change the interference color (background color).



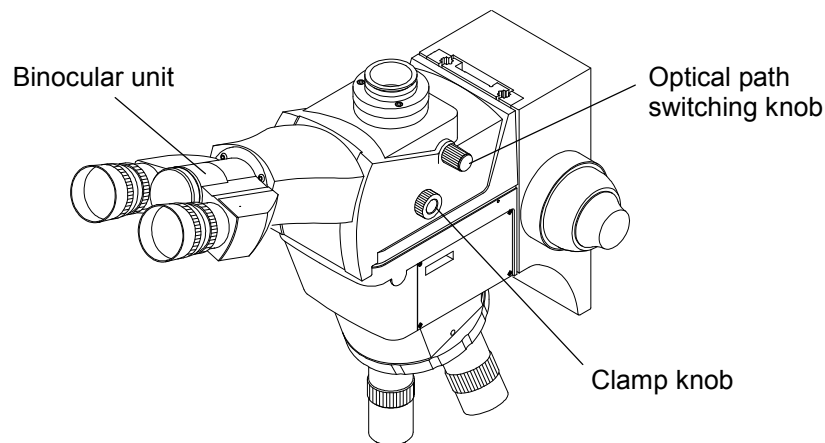
- Note**
- Adjust the brightness of the illuminator as required. Depending on the characteristic of a workpiece and the observation magnification setting, the brightness may be insufficient even at the maximum brightness setting, and it may be difficult to observe the interference color.

3.8 Operating the Tilting Head

This section explains the operating procedure when using the microscope in which the trinocular tube is tilting head type.

3.8.1 Adjusting the Observation Height (Angle) of the Binocular Unit

- 1) Loosen the clamp knob on the right side face of the Tilting Head.
- 2) Move the binocular unit at a desired height (angle) while holding the unit by hand, then tighten the clamp knob.



3.8.2 Switching the Optical Path

The Tilting Head incorporates an optical path switching mechanism.

The transmission ratio between the binocular observation optical path and the TV/laser optical path can be switched to 100%:0% or 0%:100%. Operate the knob as illustrated in the figure.

Turn the knob clockwise, and the TV observation and the laser irradiation become possible



Turn the knob counterclockwise, and the inspection through eyepieces becomes possible



1. When performing laser machining be sure to turn the optical path switching knob fully clockwise.
2. When performing laser machining never remove the laser-protective filters.
3. Under no circumstances look into the eyepieces or the binocular unit from which the eyepieces have been removed during the laser oscillation.

TIP The protection filter cuts the light around 532nm in the visible region. Therefore the green light is cut, the observation image becomes pinkish.

4

Maintenance and Inspection

This section describes the FS70 microscope unit daily maintenance such as cleaning, and replacing consumable parts.

4.1 Daily Maintenance

Daily maintenance and inspection should be done to maximize performance and ensure long and safe use. Dust and dirt are particularly harmful to the microscope unit. It should be cleaned daily and stored carefully.

4.1.1 Cleaning optical components

Clean lenses, filters, and other optical components as follows.

(1) Dust

Remove dust on the lenses with a lens brush or by wiping lightly with gauze.

(2) Fingerprints and oily substances

Fingerprints and oil must be wiped off with alcohol-soaked (ethanol, methanol) lens paper or gauze.

4.1.2 Cleaning metal parts

Lightly wipe metal parts with a silicon cloth.

Note Surface discoloration or paint peeling may result if metal parts are cleaned with cleaning agents, solvents or metal polish. Avoid cleaning the instrument in these ways whenever possible.

4.1.3 Storage

When the microscope unit is not in use, wrap it in a vinyl cover or its equivalent and store in a place where the humidity is low, so mold will not grow. The objectives and eyepieces must be stored in a case with desiccant.

4.2 Periodic Inspections

A service engineer should periodically inspect the FS70 microscope unit to maintain its high performance. Contact your dealer or nearest Mitutoyo Service Center.

4.3 Replacing the Bulb

The halogen bulb and stage glass are consumables and need to be replaced. Follow the replacement procedure described in the instructions in safety.

Important

Do not absolutely perform disassembly except for the purpose of replacing the specified consumable described in this section. Otherwise, it may deteriorate the performance of the microscope unit or damage the unit.



CAUTION

While the bulb is turned on, the bulb and its peripheral part become very hot. To prevent a burn, do not replace the bulb until it and the peripheral have sufficiently cooled. (Wait for about 30 minutes as a guide.)

5

Troubleshooting

When the FS70 microscope unit malfunctions, diagnose the problem and remedy the situation with the aid of the following tables. If the problem cannot be resolved with the procedures presented here, contact your dealer or nearest Mitutoyo Service Center.

5.1 Problems with the Observed

| Symptom | Checkpoints | Remedies | Notes |
|--|---|---|-------|
| Obstacles or dark areas appear in the field of view | 1) Is the objective deviated from the optical axis since the revolver was not rotated correctly to the click stop position? | 1) Set the revolver in the correct position. | 1.3.1 |
| | 2) Is the aperture diaphragm centered correctly? | 2) Center the aperture diaphragm correctly. | 2.2.6 |
| | 3) Is there dirt on the lens and the workpiece? | 3) Clean it. | 4.1.1 |
| Poor contrast, resolution, or image quality | 1) Is there dirt on the lens and the workpiece? | 1) Clean it. | 4.1.1 |
| | 2) Is the intensity of illumination appropriate? | 2) Increase the brightness. | 1.3.2 |
| | 3) Is the aperture diaphragm stopped down excessively? | 3) Open the aperture diaphragm. | 1.3.1 |
| | 4) Are you observing the sample through a medium other than air, for example, a glass cover? | 4) Use the specified objective. Remove the glass cover or other intervening medium. | |
| The image is partly blurred | 1) Is the workpiece tilted? | 1) Adjust inclination between the workpiece and the main axis of the microscope. | |
| | 2) Is the objective screwed in firmly? | 2) Mount the objective lens firmly in the mount. | 2.2.3 |
| The image sways | 1) Is the aperture diaphragm centered correctly? | 1) Center the aperture diaphragm correctly. | 2.2.6 |

5.2 Problems During Operation

| Symptom | Checkpoints | Remedies | Notes |
|--|--|---|-----------------|
| The right and left images do not come together when observed through the binocular eyepieces | 1) Is the pupil distance appropriate for the operator? | 1) Is the pupil distance appropriate for the operator? | 2.2.10 |
| Inspection fatigues eyes easily | 1) Is the diopter of the eyepiece adjusted correctly for the operator? 2) Is the illuminator brightness too high? | 1) Re-adjust the diopter. 2) Adjust the illuminator to the optimal brightness. | 2.2.10 1.3.2 |
| The image does not move smoothly when a workpiece is traveled | 1) Is the workpiece holder on the stage is securely fixed? | 1) Tighten the holder clamp screws securely. | |

5.3 Electrical Problems

| Symptom | Checkpoints | Remedies | Notes |
|------------------------------------|---|--|-----------------------|
| The bulb does not light | 1) Has the bulb burned out? 2) Has the fuse burned out? | 1) Replace the bulb. 2) Replace the fuse. | 4.3 |
| The bulbs burn out quickly | 1) Is the correct bulb being used? (JCR12V100W10H) | 1) Check the voltage rating and use the specified bulb. | 4.3 |
| The brightness is insufficient | 1) Is the aperture diaphragm stopped down too far? 2) Is the correct bulb being used? 3) Is the objective or the filter contaminated? | 1) Open the aperture diaphragm. 2) Use the specified bulb. 3) Clean the optical parts. | 1.3.1 4.3 4.1.1 |
| The illumination varies (flickers) | 1) Is the bulb about to expire? 2) Are there any loose power connector, bulb socket, etc.? | 1) Replace the bulb. 2) Connect properly. | 4.3 2.2.1 |

6

Specifications

This chapter lists the specifications of the FS70 microscope unit standard components, accessories, and options.

6.1 Microscope Unit

| Model | FS70 FS70-S | FS70-TH FS70-THS | FS70Z FS70Z-S | FS70Z-TH FS70Z-THS | FS70L FS70L-S | FS70L-TH FS70L-THS | FS70L4 FS70L4-S | FS70L4-TH FS70L4-THS | | |
|-------------------------------------|------------------------------|---|--|------------------------|--------------------------------------|--|--|-------------------------|--------------------------|----------|
| Order No. | 378-184-1 378-184-2 | 378-184-3 378-184-4 | 378-185-1 378-185-2 | 378-185-3 378-185-4 | 378-186-1 378-186-2 | 378-186-3 378-186-4 | 378-187-1 378-187-2 | 378-187-3 378-187-4 | | |
| Erecting trinocular tube | Pupil distance adjustment | | Siedntopf type, Pupil distance adjusting range: 51 to 76 mm | | | | | | | |
| | Number of fields of view | | 24 | | | | | | | |
| | Tilting angle | | — | 0 to 20° | — | 0 to 20° | — | 0 to 20° | — | 0 to 20° |
| | Optical path switching | | *1 | *2 | *1 | Switching type: Observation/Laser (TV)= 100%:0%, 0%:100% | | | | |
| | Protection filter | | — | | | Built-in laser safety filter | | | | |
| Main unit | Tube lens | | 1× fixed | | 1× to 2× variable | | 1× fixed | | | |
| | Laser compatibility *3 | | NUV/Visible/NIR can be retrofitted. *4 | | — | | NUV/Visible/NIR 355/532/1064 nm | | UV/Visible 266/532 nm | |
| Focus adjustment unit | Coarse/fine feed | | One-axis coarse/fine feed (coarse: 3.8 mm/full-turn, fine: 0.1 mm/full-turn) | | | | | | | |
| | Displacement | | 50 mm with the left/right wheel | | | | | | | |
| | Movable load | | 18 kg | | | | | | | |
| Camera mount | | C mount (used with Adapter B) | | | TV port attaching to a laser unit | | C mount (slide switch type, GIF filter built-in) | | | |
| Movable load on the optical tube | | 14.5kg | 13.6kg | 14.1kg | 13.2kg | 14.2kg | 13.5kg | 13.9kg | 13.1kg | |
| Microscope unit mass *5 | | 6.1kg | 7.1kg | 6.6kg | 7.5kg | 6.4kg | 7.2kg | 6.7kg | 7.5kg | |
| Reflected illuminator unit | | Bright-field reflected illumination, Koehler illumination with aperture diaphragm | | | | | | | | |

*1)Fixed type: Observation/TV =50%:50%

*2)Switching type: Observation/TV=100%:0%, 0%:100%

*3)The TV port is not attached to FS70L. Be sure to use the laser unit with the TV port.

*4)FS70 and FS70-S can be retrofitted to the laser correspondence by installing trinocular tube 0:100 (No.378-156). Do not irradiate the laser with DIC unit installed in case of the retrofit to the laser correspondence. DIC unit is damaged.

*5)The sum total of [Erecting trinocular tube] and [Main unit] and [Focus adjustment unit]

6.2 Laser Port

| | | | | | |
|--|-------|-----|------|--------|-----|
| Distance between the laser mount and the mask (mm) | | | | 78 | |
| Applicable Model | FS70L | | | FS70L4 | |
| Wavelength (nm) | 355 | 532 | 1064 | 266 | 532 |
| Laser input upper limit (mJ / cm ²) | 18 | 41 | 82 | 15 | 75 |
| Pulse width (ns) | 10 | 10 | 10 | 10 | 10 |
| Transmittance (%) | 70 | 71 | 78 | 75 | 38 |

Note Above-mentioned transmittance has dispersion of approximately 5%.

| Product | NIR / NUV 20× | NIR / NUV 50× | NIR / NUV 100× |
|--|------------------|------------------|-------------------|
| Beam diameter upper limit [TEM00] (mask size) (mm) | φ 10 (□7) | φ 4.3 (□3) | φ 2.8 (□2) |

Note Laser processing exceeding the above-mentioned mask size cannot be carried out.

6.3 Standard Accessories

| Model | FS70/ FS70-S FS70-TH/ FS70-THS | FS70Z/ FS70Z-S FS70ZTH/ FS70Z-THS | FS70L/ FS70L-S FS70LTH/ FS70L-THS | FS70L4/ FS70L4-S FS70L4TH/ FS70L4-THS |
|-------------------------------------|--------------------------------------|---|---|---|
| Order No. : 378- | 184-1/184-2 184-3/184-4 | 185-1/185-2 185-3/185-4 | 186-1/186-2 186-3/186-4 | 187-1/187-2 187-3/187-4 |
| C mount | — | — | — | ○ |
| Hex-socket head screw M4×18, 5 pcs. | ○ | ○ | ○ | ○ |
| Hex-socket head screw M4×14, 5 pcs. | ○ | ○ | ○ | ○ |
| Allen key (nominal 3 mm) | ○ | ○ | ○ | ○ |
| Allen key (nominal 1.5 mm) | ○ | ○ | ○ | ○ |
| User's Manual | ○ | ○ | ○ | ○ |

6.4 Optional Accessories

| Order No. | Part name | | FS70/ FS70-S FS70-TH/ FS70-THS | FS70Z/ FS70Z-S FS70ZTH/ FS70Z-THS | FS70L/ FS70L-S FS70LTH/ FS70L-THS | FS70L4/ FS70L4-S FS70L4TH/ FS70L4-THS |
|--------------------|--|------------------------------------|--------------------------------------|---|---|--|
| 378-856 | Eyepiece 10× | ※) For details, refer to next page | ○ | ○ | ○ | ○ |
| 378-857 | Eyepiece 15× | | ○ | ○ | ○ | ○ |
| 378-858 | Eyepiece 20× | | ○ | ○ | ○ | ○ |
| Refer to next page | Objective M Plan Apo series | | ○ | ○ | ○ | ○ |
| | Objective M Plan Apo SL series | | ○ | ○ | ○ | ○ |
| | Objective G Plan Apo series | | ○ | ○ | ○ | ○ |
| Refer to page 6-5 | Objective M Plan NIR series | | — | — | ○ | — |
| | Objective LCD Plan NIR series | | — | — | ○ | — |
| | Objective M Plan NUV series | | — | — | ○ | — |
| | Objective LCD Plan NUV series | | — | — | ○ | — |
| | Objective M Plan UV series | | — | — | — | ○ |
| 378-042 | □Adapter B | | ○ | ○ | — | — |
| 375-054 | ■0.5× camera adapter unit | | ○ | ○ | — | — |
| 378-156 | Trinocular tube 0 : 100 | | ○ (TH type is excluded) | — | — | — |
| 378-062 | Manual focusing unit | | ○ | ○ | ○ | ○ |
| 378-061 | Power focusing unit | | ○ | ○ | ○ | ○ |
| 378-016 | Power Revolver (with four aligning holes) | | ○ | ○ | ○ | ○ |
| 378-017 | Power Revolver (with four holes) | | ○ | ○ | ○ | ○ |
| 378-018 | Adjustable Revolver | | ○ | ○ | ○ | ○ |
| 378-019 | Revolver (with four holes) | | ○ | ○ | ○ | ○ |
| 378-730 | △Simple stand | | ○ | ○ | ○ | ○ |
| 378-020 | ▲Stage | | ○ | ○ | ○ | ○ |
| 378-736 | ▲Transmitted illumination unit | | ○ | ○ | ○ | ○ |
| 378-025 | ▲X-Y table | | ○ | ○ | ○ | ○ |
| 378-092 | ☆Polarization unit | | — | ○ | — | — |
| 378-093 | ☆Polarization unit | | ○ | — | ○ | — |
| 378-094 | Polarization unit | | — | — | — | ○ |
| 378-076 | ★ Differential interference contrast unit | for 100×, SL50×, SL80× | ○ | ○ | — | — |
| 378-078 | | for 50×, SL20× | ○ | ○ | — | — |
| 378-079 | | for 20× | ○ | ○ | — | — |
| 378-080 | | for 5×, 10× | ○ | ○ | — | — |
| 378-700 | ▽Fiber-optic illuminator unit | | ○ | ○ | ○ | ○ |
| 12AAB251 | ▼Color filter (for Fiber-optic illuminator unit) ND2 | | ○ | ○ | ○ | ○ |

| Order No. | Part name | FS70/ FS70-S FS70-TH/ FS70-THS | FS70Z/ FS70Z-S FS70Z-TH/ FS70Z-THS | FS70L/ FS70L-S FS70L-TH/ FS70L-THS | FS70L4/ FS70L4-S FS70L4-TH/ FS70L4-THS |
|-----------|---|--------------------------------------|--|--|---|
| 12AAB252 | ▼Color filter (for Fiber-optic illuminator unit) ND8 | ○ | ○ | ○ | ○ |
| 12BAA583 | ▼Color filter (for Fiber-optic illuminator unit) GIF | ○ | ○ | ○ | ○ |
| 12BAA584 | ▼Color filter (for Fiber-optic illuminator unit) LB80 | ○ | ○ | ○ | ○ |
| 12AAA643 | Color filter ND2 | ○ | — | ○ | ○ |
| 12AAA644 | Color filter ND8 | ○ | — | ○ | ○ |
| 12AAA645 | Color filter GIF | ○ | — | ○ | ○ |
| 12AAA646 | Color filter LB80 | ○ | — | ○ | ○ |

When the ■ mark is used, will be simultaneous with □ mark Adapter B(No.378-042).

When the ▲ mark is used, will be simultaneous with △ mark Simple stand(No.378-730).

When the ★ mark is used, will be simultaneous with ☆ mark Polarization unit(No.378-092,093).

When the ▼ mark is used, will be simultaneous with ▽ mark Fiber-optic illuminator unit(No.378-700).

[Eyepiece]

| Order No. | Product | Magnification | Field number | Diopter Correction Range |
|-----------|----------|---------------|--------------|--------------------------|
| 378-856 | WF10×/24 | 10× | 24 | -8D~+4D |
| 378-857 | WF15×/16 | 15× | 16 | |
| 378-858 | WF20×/12 | 20× | 12 | |

[Bright-field objectives]

| M Plan APO | | | | | | | | | | |
|-------------------------|---|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Order No. : | 378- | 800-3 | 801-6 | 802-6 | 803-3 | 804-3 | 805-3 | 814-4 | 806-3 | 815-4 |
| Magnification | | 1× | 2× | 5× | 10× | 20× | 50× | | 100× | |
| NA | | 0.025 | 0.055 | 0.14 | 0.28 | 0.42 | 0.55 | 0.75 | 0.7 | 0.9 |
| Working distance (mm) | | 11 | 34 | 34 | 34 | 20 | 13 | 5.2 | 6 | 1.3 |
| Optical system | Infinity-correction system (independent aberration correction) | | | | | | | | | |
| Usable wavelengths (nm) | 435.8 to 656.3 | | | | | | | | | |
| Parfocal distance (mm) | 95 | | | | | | | | | |
| Mounting threads | Outer diameter: 26 mm, 36 threads/inch: according to JIS B-7141 | | | | | | | | | |
| Applicable Model | FS70, FS70Z, FS70L, FS70L4 | | | | | | | | | |

| M Plan APO SL | | | | | | G Plan APO (t 3.5mm) | | |
|-------------------------|---|-------|-------|-------|-------|-------------------------|------|-------|
| Order No. : | 378- | 810-3 | 811-3 | 812-3 | 813-3 | 816-3 | 847 | 848-3 |
| Magnification | | 20× | 50× | 80× | 100× | 200× | 20× | 50× |
| NA | | 0.28 | 0.42 | 0.5 | 0.55 | 0.62 | 0.28 | 0.50 |
| Working distance (mm) | | 30.5 | 20.5 | 15 | 13 | 13 | 30.6 | 15.08 |
| Optical system | Infinity-correction system (independent aberration correction) | | | | | | | |
| Usable wavelengths (nm) | 435.8 to 656.3 | | | | | | | |
| Parfocal distance (mm) | 95 | | | | | | | |
| Mounting threads | Outer diameter: 26 mm, 36 threads/inch: according to JIS B-7141 | | | | | | | |
| Applicable Model | FS70, FS70Z, FS70L, FS70L4 | | | | | | | |

6. Specifications

| | M Plan NIR | | | | | LCD Plan NIR | | | |
|-------------------------|---|-------|-------|-------|-------|--------------|-----------|-------|-------|
| | | | | | | (t 1.1mm) | (t 0.7mm) | | |
| Order No. : | 378- | 822-5 | 823-5 | 824-5 | 825-5 | 826-5 | 827-5 | 828-5 | 829-5 |
| Magnification | | 5× | 10× | 20× | 50× | 100× | 20× | 50× | |
| NA | | 0.14 | 0.26 | 0.4 | 0.42 | 0.5 | 0.4 | 0.42 | 0.42 |
| Working distance (mm) | | 37.5 | 30.5 | 20 | 17 | 12 | 20.35 | 17.5 | 17.5 |
| Optical system | Infinity-correction system (independent aberration correction) | | | | | | | | |
| Usable wavelengths (nm) | 480 to 1800 | | | | | | | | |
| Parfocal distance (mm) | 95 | | | | | | | | |
| Mounting threads | Outer diameter: 26 mm, 36 threads/inch: according to JIS B-7141 | | | | | | | | |
| Applicable Model | FS70L | | | | | | | | |

| | M Plan NUV | | | LCD Plan NUV | |
|-------------------------|---|-------|-------|--------------|-------|
| | | | | (t 0.7mm) | |
| Order No. : | 378- | 817-4 | 818-4 | 819-4 | 820-4 |
| Magnification | | 20× | 50× | 100× | 50× |
| NA | | 0.4 | 0.42 | 0.5 | 0.42 |
| Working distance (mm) | | 17 | 15 | 11 | 15 |
| Optical system | Infinity-correction system (independent aberration correction) | | | | |
| Usable wavelengths (nm) | 350 to 620 | | | | |
| Parfocal distance (mm) | 95 | | | | |
| Mounting threads | Outer diameter: 26 mm, 36 threads/inch: according to JIS B-7141 | | | | |
| Applicable Model | FS70L | | | | |

| | M Plan UV | | | |
|-------------------------|---|-------|-------|-------|
| | | | | |
| Order No. : | 378- | 837-5 | 838-5 | 839-5 |
| Magnification | | 20× | 50× | 80× |
| NA | | 0.36 | 0.40 | 0.55 |
| Working distance (mm) | | 15 | 12 | 10 |
| Optical system | Infinity-correction system (independent aberration correction) | | | |
| Usable wavelengths (nm) | 266, 550 | | | |
| Parfocal distance (mm) | 95 | | | |
| Mounting threads | Outer diameter: 26 mm, 36 threads/inch: according to JIS B-7141 | | | |
| Applicable Model | FS70L4 | | | |

Mitutoyo also provides a wide range of objectives in addition to the ones listed above. See catalog (No. 4208) for details.

Important When performing laser processing, be sure to use the NIR/NUV/UV objectives for processing.
If you perform laser processing using another objectives for observation, the lens surface may be damaged, resulting in noticeable deterioration of the image.

Note With small output lasers, you may not be able to perform processing at the objectives of 20x or lower magnification.
For information about the beam diameter (mask size) for each magnification of the NIR/NUV/UV objectives for processing, see Section 6.2, "Laser Port".

Note When using a 1x objective, the periphery of the field of view is dark. Should use the polarization unit of optional accessory together if you require a clear image.

6.5 Objectives, Tube Lens, Eyepieces Specification Table

<FS UL WD Series>

| M plan apochromat objective (for bright-field) | | | | | Eyepiece WF, wide field of view | | | | | | | | |
|---|-------|------|-----|-----------|---------------------------------|------|--------------|--------------|------|--------------|--------------|------|--------------|
| | | | | | WF10×/24 | | | WF15×/16 | | | WF20×/12 | | |
| | | | | | Tube lens 1× | | | Tube lens 1× | | | Tube lens 1× | | |
| M | N.A. | W.D. | f | R (μm) | T.M. | φ | F.D. (μm) | T.M. | φ | F.D. (μm) | T.M. | φ | F.D. (μm) |
| 1× | 0.025 | 11 | 200 | 11.0 | 10× | 24 | 1011.0 | 15× | 16 | 821.0 | 20× | 12 | 725.7 |
| 2× | 0.055 | 34 | 100 | 5.0 | 20× | 12 | 220.8 | 30× | 8 | 177.5 | 40× | 6 | 155.8 |
| 5× | 0.14 | 34 | 40 | 2.0 | 50× | 4.8 | 34.4 | 75× | 3.2 | 27.6 | 100× | 2.4 | 24.2 |
| 10× | 0.28 | 33.5 | 20 | 1.0 | 100× | 2.4 | 8.6 | 150× | 1.6 | 6.9 | 200× | 1.2 | 6.1 |
| 20× | 0.42 | 20 | 10 | 0.7 | 200× | 1.2 | 3.3 | 300× | 0.8 | 2.7 | 400× | 0.6 | 2.4 |
| 50× | 0.55 | 13 | 4 | 0.5 | 500× | 0.48 | 1.4 | 750× | 0.32 | 1.3 | 1000× | 0.24 | 1.2 |
| 100× | 0.70 | 6 | 2 | 0.4 | 1000× | 0.24 | 0.8 | 1500× | 0.16 | 0.7 | 2000× | 0.12 | 0.7 |

<FS UL WD SL Series>

| M plan apochromat objective (for bright-field) | | | | | Eyepiece WF, wide field of view | | | | | | | | |
|---|------|------|-----|-----------|---------------------------------|------|--------------|--------------|------|--------------|--------------|------|--------------|
| | | | | | WF10×/24 | | | WF15×/16 | | | WF10×/24 | | |
| | | | | | Tube lens 1× | | | Tube lens 1× | | | Tube lens 1× | | |
| M | N.A. | W.D. | f | R (μm) | T.M. | φ | F.D. (μm) | T.M. | φ | F.D. (μm) | T.M. | φ | F.D. (μm) |
| SL20× | 0.28 | 30.5 | 10 | 1.0 | 200× | 1.2 | 6.1 | 300× | 0.8 | 5.2 | 400× | 0.6 | 4.8 |
| SL50× | 0.42 | 20.5 | 4 | 0.7 | 500× | 0.48 | 2.2 | 750× | 0.32 | 2.0 | 1000× | 0.24 | 1.9 |
| SL80× | 0.50 | 15 | 2.5 | 0.55 | 800× | 0.3 | 1.6 | 1200× | 0.2 | 1.3 | 1600× | 0.15 | 1.3 |
| SL100× | 0.55 | 13 | 2 | 0.5 | 1000× | 0.24 | 1.2 | 1500× | 0.16 | 1.1 | 2000× | 0.12 | 1.0 |
| SL200× | 0.62 | 13 | 1 | 0.4 | 2000× | 0.12 | 0.8 | 3000× | 0.08 | 0.8 | 4000× | 0.06 | 0.8 |

<FS UL WD NIR Series>

| M plan NIR objective (for bright-field) | | | | | Eyepiece WF, wide field of view | | | | | | | | |
|--|------|------|----|-----------|---------------------------------|------|--------------|--------------|------|--------------|--------------|------|--------------|
| | | | | | WF10×/24 | | | WF15×/16 | | | WF10×/24 | | |
| | | | | | Tube lens 1× | | | Tube lens 1× | | | Tube lens 1× | | |
| M | N.A. | W.D. | f | R (μm) | T.M. | φ | F.D. (μm) | T.M. | φ | F.D. (μm) | T.M. | φ | F.D. (μm) |
| 5× | 0.14 | 37.5 | 40 | 2.0 | 50× | 4.8 | 34.4 | 75× | 3.2 | 27.6 | 100× | 2.4 | 24.2 |
| 10× | 0.26 | 30.5 | 20 | 1.1 | 100× | 2.4 | 9.6 | 150× | 1.6 | 7.7 | 200× | 1.2 | 6.8 |
| 20× | 0.40 | 20 | 10 | 0.7 | 200× | 1.2 | 3.5 | 300× | 0.8 | 2.9 | 400× | 0.6 | 2.6 |
| 50× | 0.42 | 17 | 4 | 0.7 | 500× | 0.48 | 2.2 | 750× | 0.32 | 2.0 | 1000× | 0.24 | 1.9 |
| 100× | 0.50 | 12 | 2 | 0.55 | 1000× | 0.24 | 1.4 | 1500× | 0.16 | 1.3 | 2000× | 0.12 | 1.2 |

<FS UL WD NUV Series>

| M plan NUV objective (for bright-field) | | | | | Eyepiece WF, wide field of view | | | | | | | | |
|--|------|------|----|-----------|---------------------------------|------|--------------|--------------|------|--------------|--------------|------|--------------|
| | | | | | WF10×/24 | | | WF15×/16 | | | WF10×/24 | | |
| | | | | | Tube lens 1× | | | Tube lens 1× | | | Tube lens 1× | | |
| M | N.A. | W.D. | f | R (μm) | T.M. | φ | F.D. (μm) | T.M. | φ | F.D. (μm) | T.M. | φ | F.D. (μm) |
| 20× | 0.40 | 17 | 10 | 0.7 | 200× | 1.2 | 3.5 | 300× | 0.8 | 2.9 | 400× | 0.6 | 2.6 |
| 50× | 0.42 | 15 | 4 | 0.7 | 500× | 0.48 | 2.2 | 750× | 0.32 | 2.0 | 1000× | 0.24 | 1.9 |
| 100× | 0.50 | 11 | 2 | 0.55 | 1000× | 0.24 | 1.4 | 1500× | 0.16 | 1.3 | 2000× | 0.12 | 1.2 |

<FS UL WD UV Series>

| M plan UV objective (for bright-field) | | | | | Eyepiece WF, wide field of view | | | | | | | | |
|---|------|------|-----|-----------|---------------------------------|------|--------------|--------------|------|--------------|--------------|------|--------------|
| | | | | | WF10×/24 | | | WF15×/16 | | | WF10×/24 | | |
| | | | | | Tube lens 1× | | | Tube lens 1× | | | Tube lens 1× | | |
| M | N.A. | W.D. | f | R (μm) | T.M. | φ | F.D. (μm) | T.M. | φ | F.D. (μm) | T.M. | φ | F.D. (μm) |
| 20× | 0.36 | 15 | 10 | 0.8 | 200× | 1.2 | 4.1 | 300× | 0.8 | 3.4 | 400× | 0.6 | 3.1 |
| 50× | 0.40 | 12 | 4 | 0.7 | 500× | 0.48 | 2.4 | 750× | 0.32 | 2.2 | 1000× | 0.24 | 2.1 |
| 80× | 0.55 | 10 | 2.5 | 0.5 | 800× | 0.3 | 1.2 | 1200× | 0.2 | 1.1 | 1600× | 0.15 | 1.1 |

- Note) M : Magnification
 N.A. : Numerical aperture
 W.D. : Working distance (mm)
 R : Resolution(μm)
 T.M. : Total magnification
 φ : Field of view (φ mm)
 F.D. : Focal depth (μm)

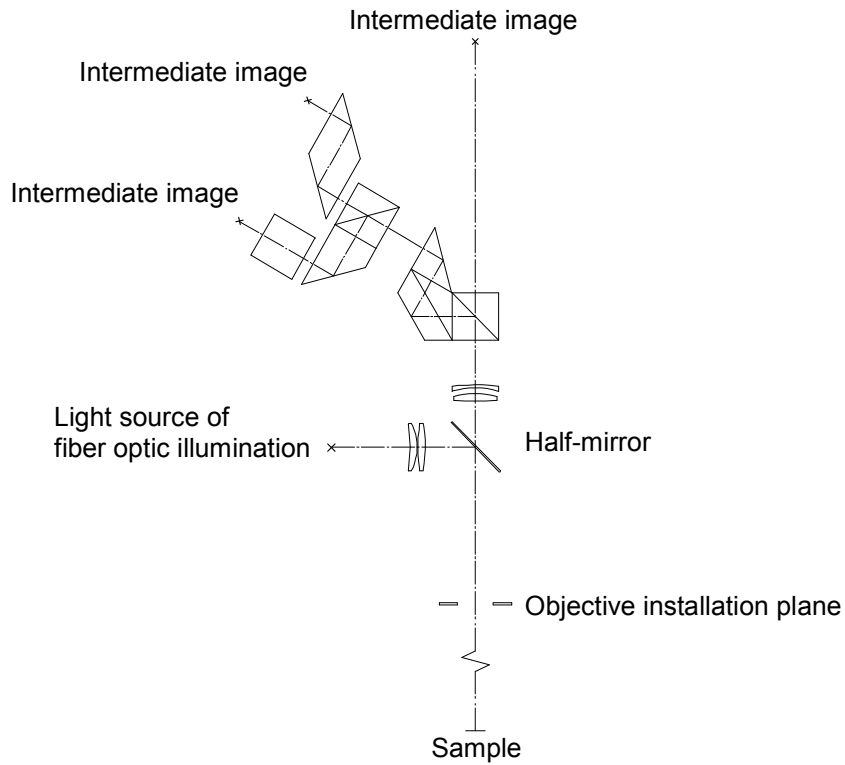
Assuming that the resolution of human eye is 2'

$$R = \frac{\lambda}{2 \times \text{N.A.}} \quad \lambda = 0.55 \mu\text{m} \text{ (Standard wavelength)}$$

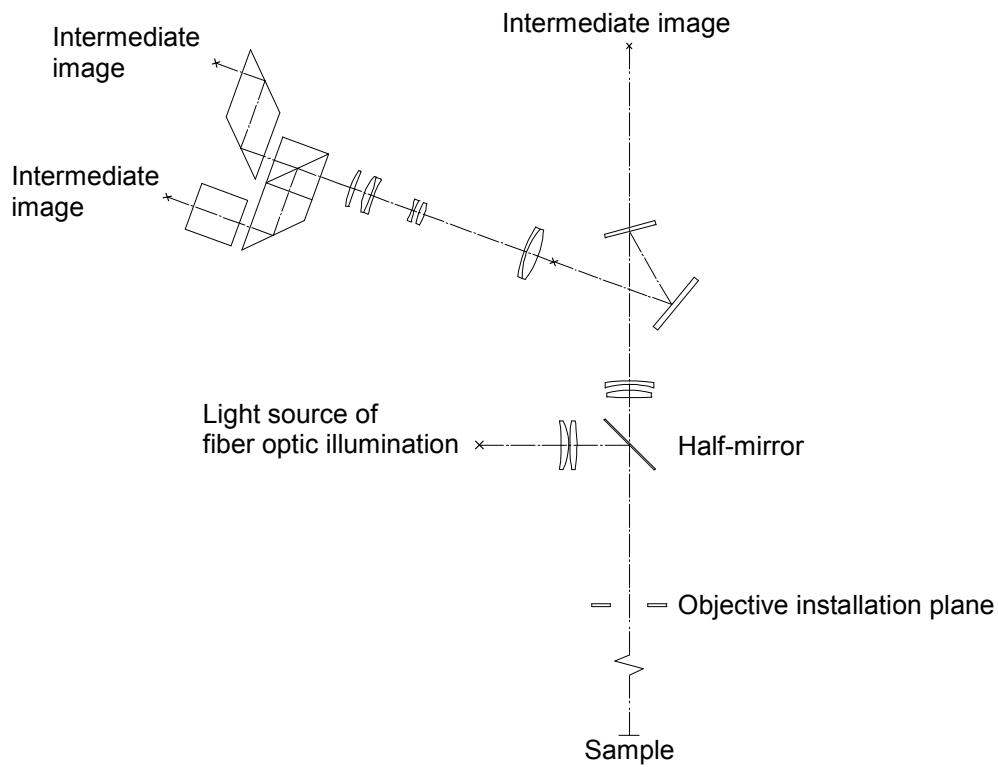
$$\text{F.D.} = \frac{\lambda}{2 (\text{N.A.})^2} + \frac{1000}{7 \times \text{N.A.} \times \text{T.M.}}$$

6.6 Layout of the Optical System

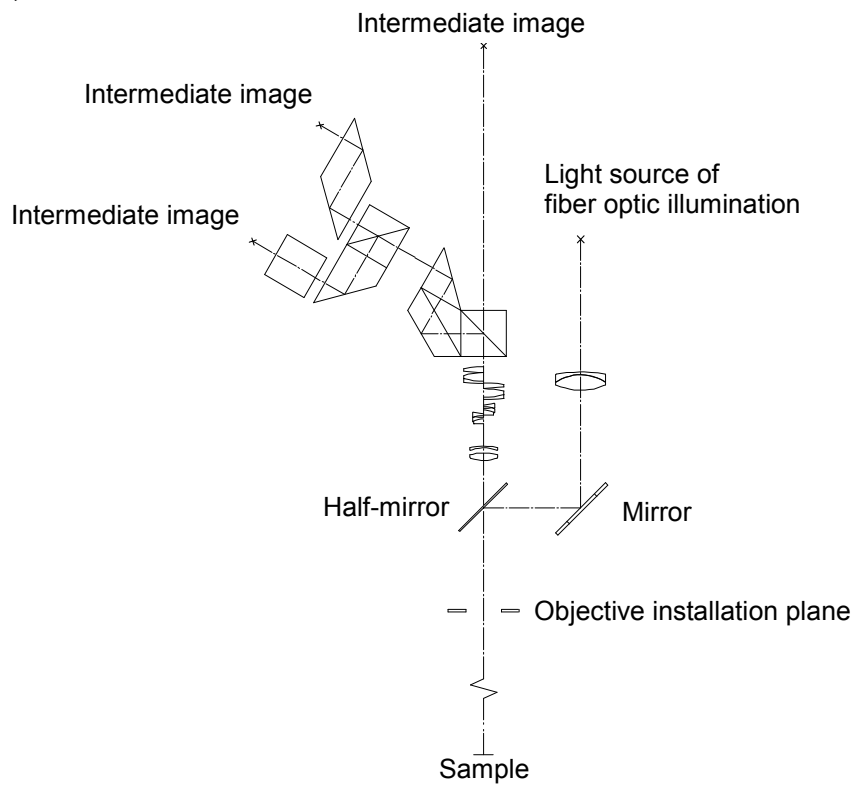
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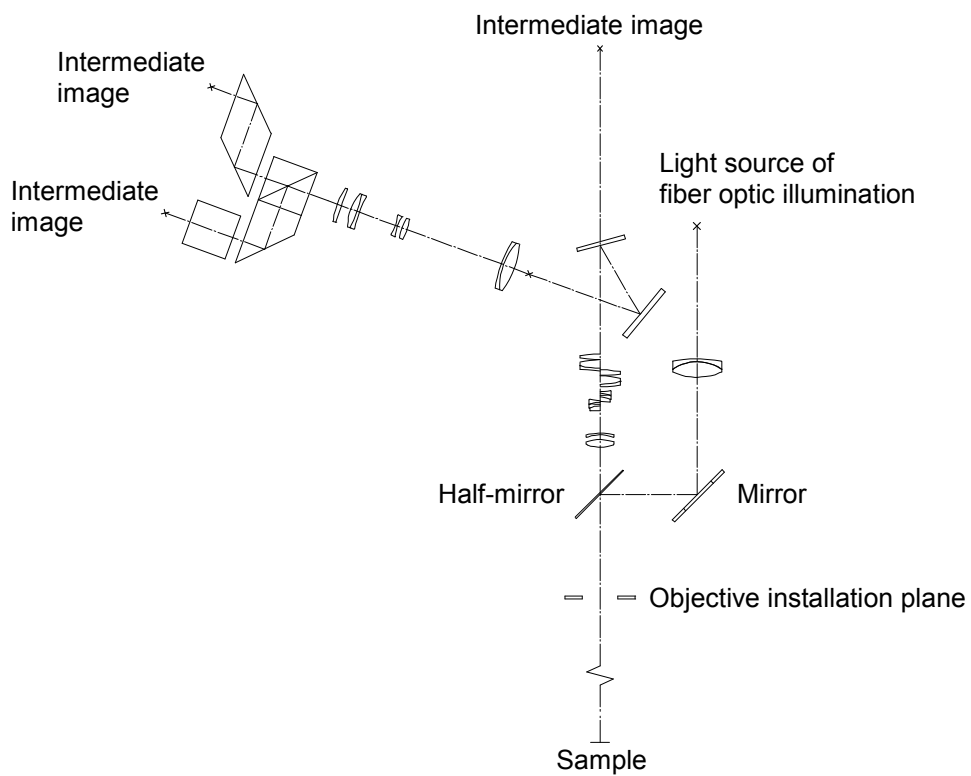
(2) FS70-TH, FS70-THS



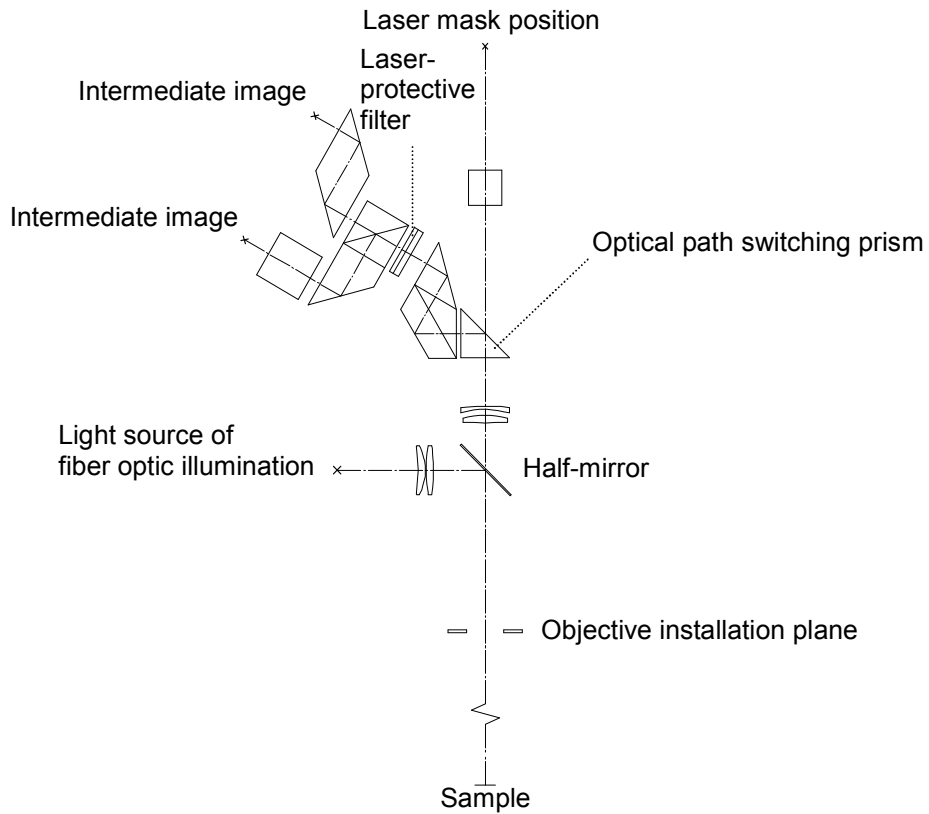
(3) FS70Z, FS70Z-S



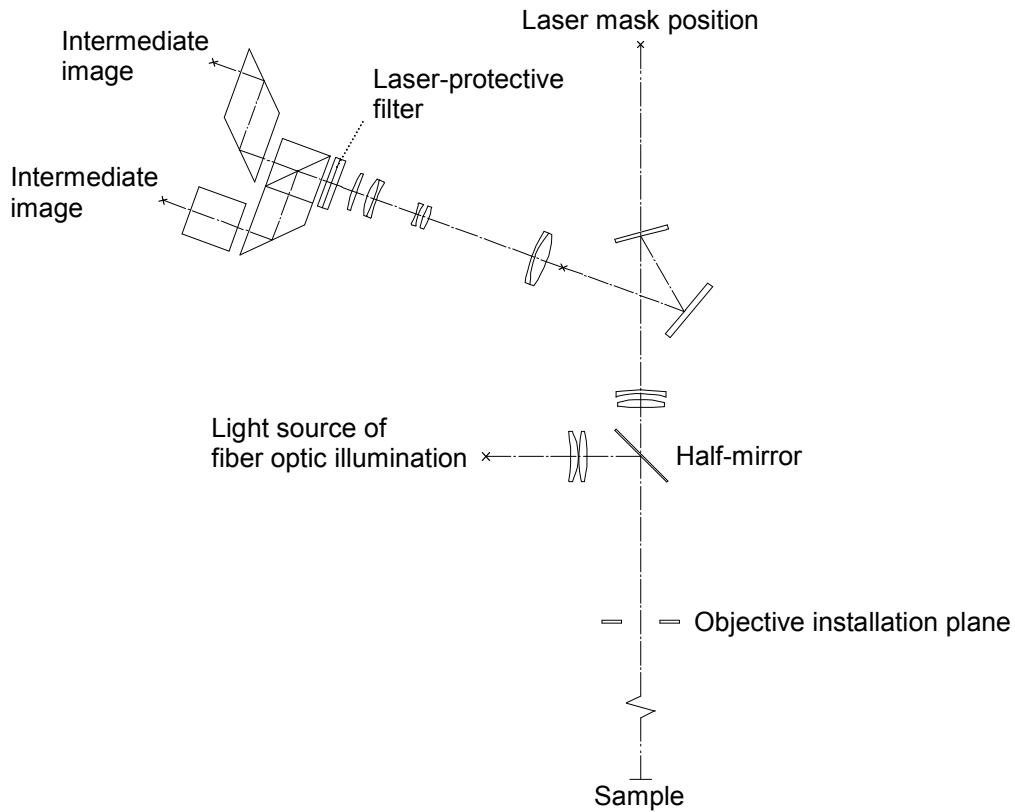
(4) FS70Z-TH, FS70Z-THS



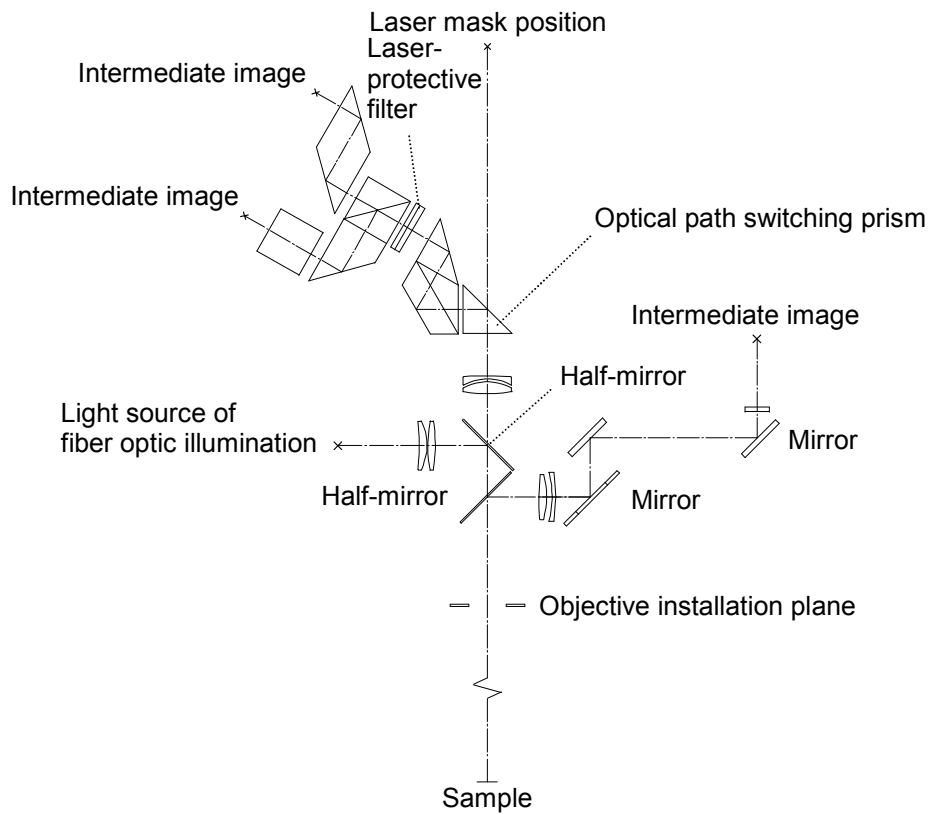
(5) FS70L, FS70L-S



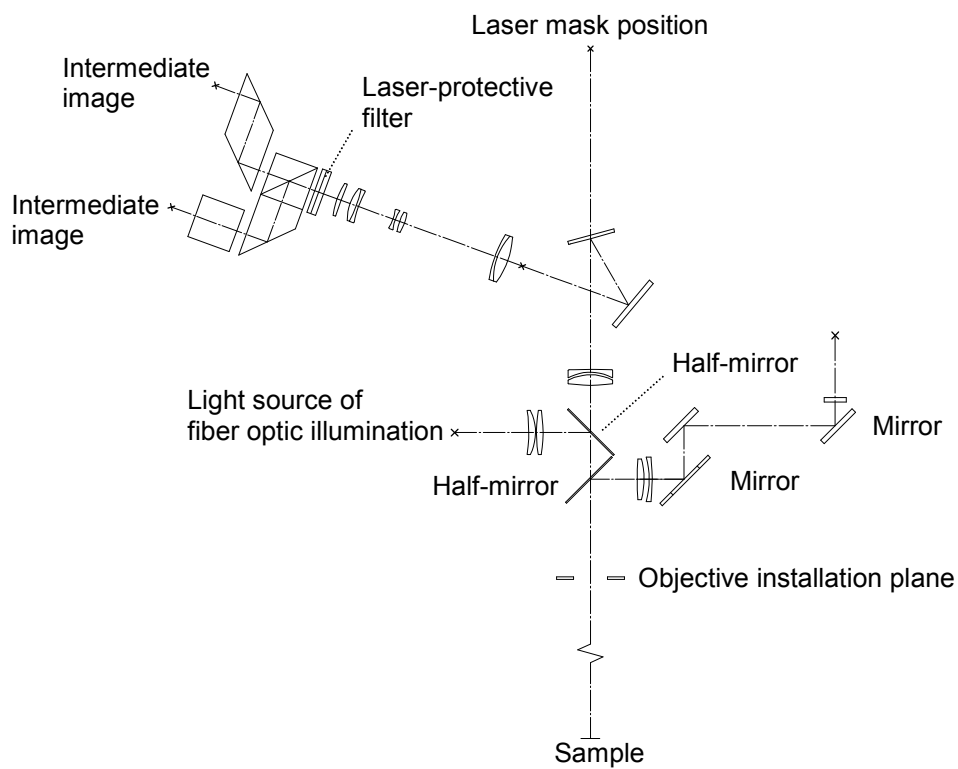
(6) FS70L-TH, FS70L-THS



(7) FS70L4, FS70L4-S



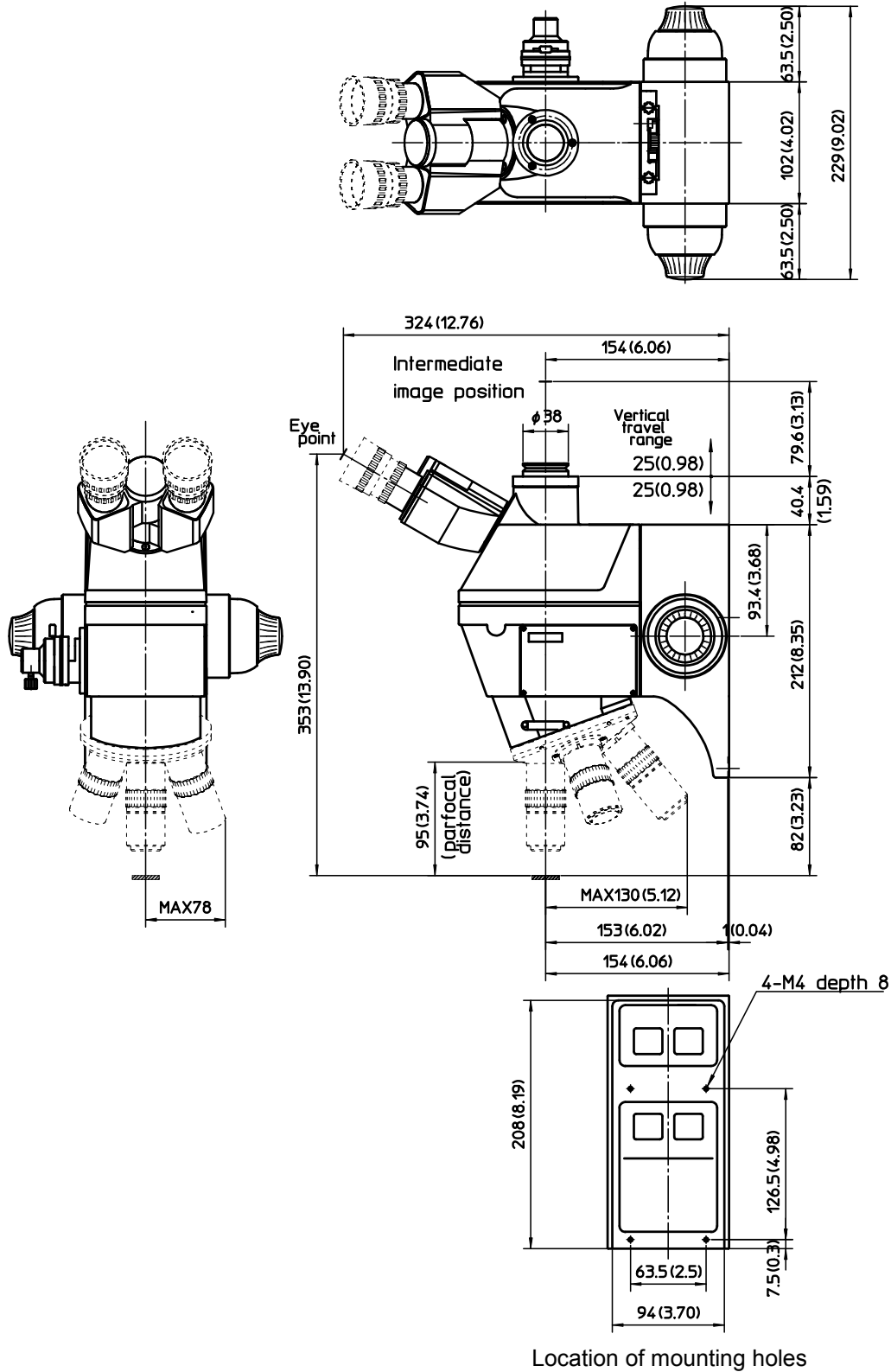
(8) FS70L4-TH, FS70L4-THS



6.7 External Dimensions

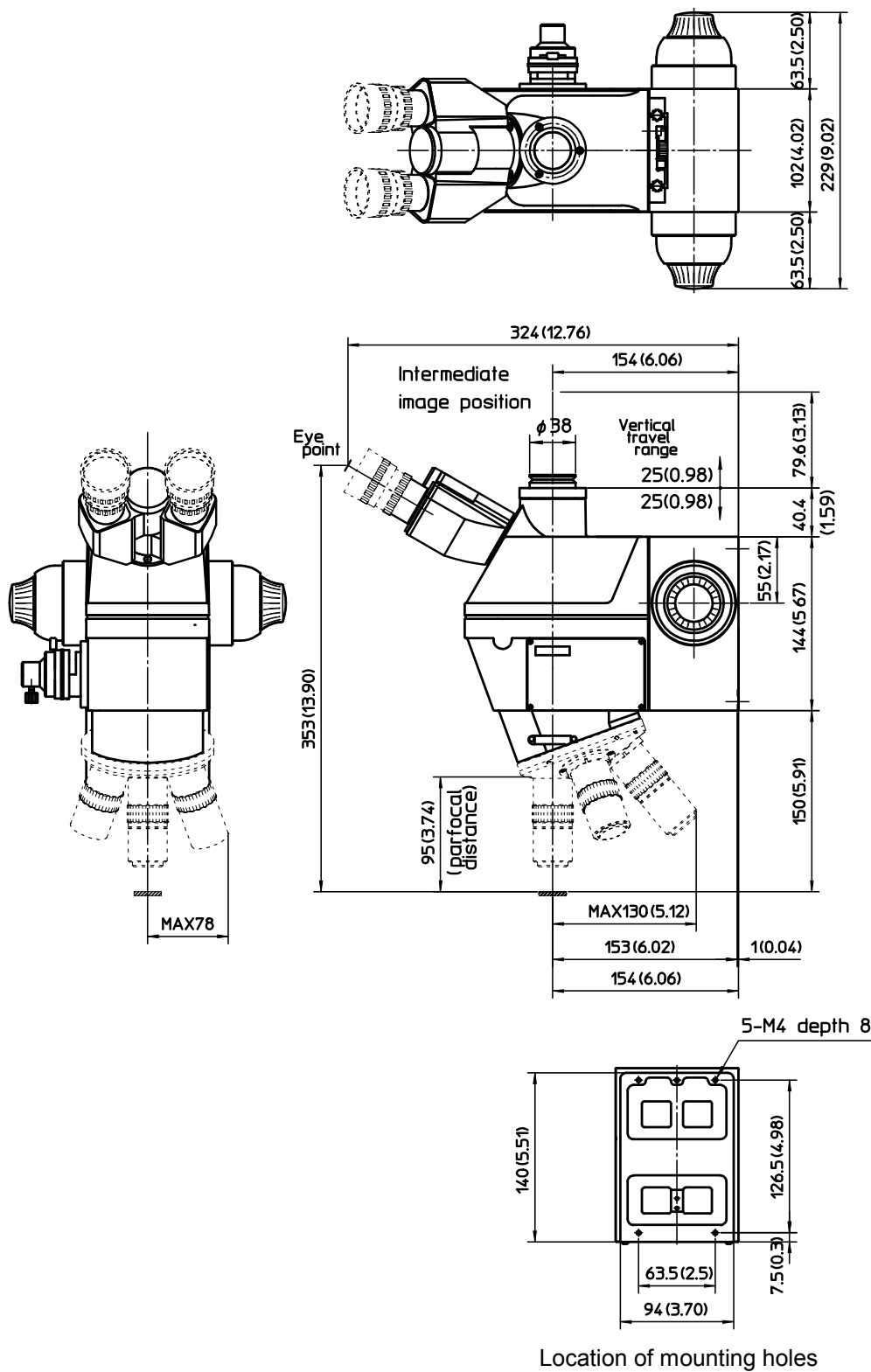
(1) FS70

Unit : mm (inch)



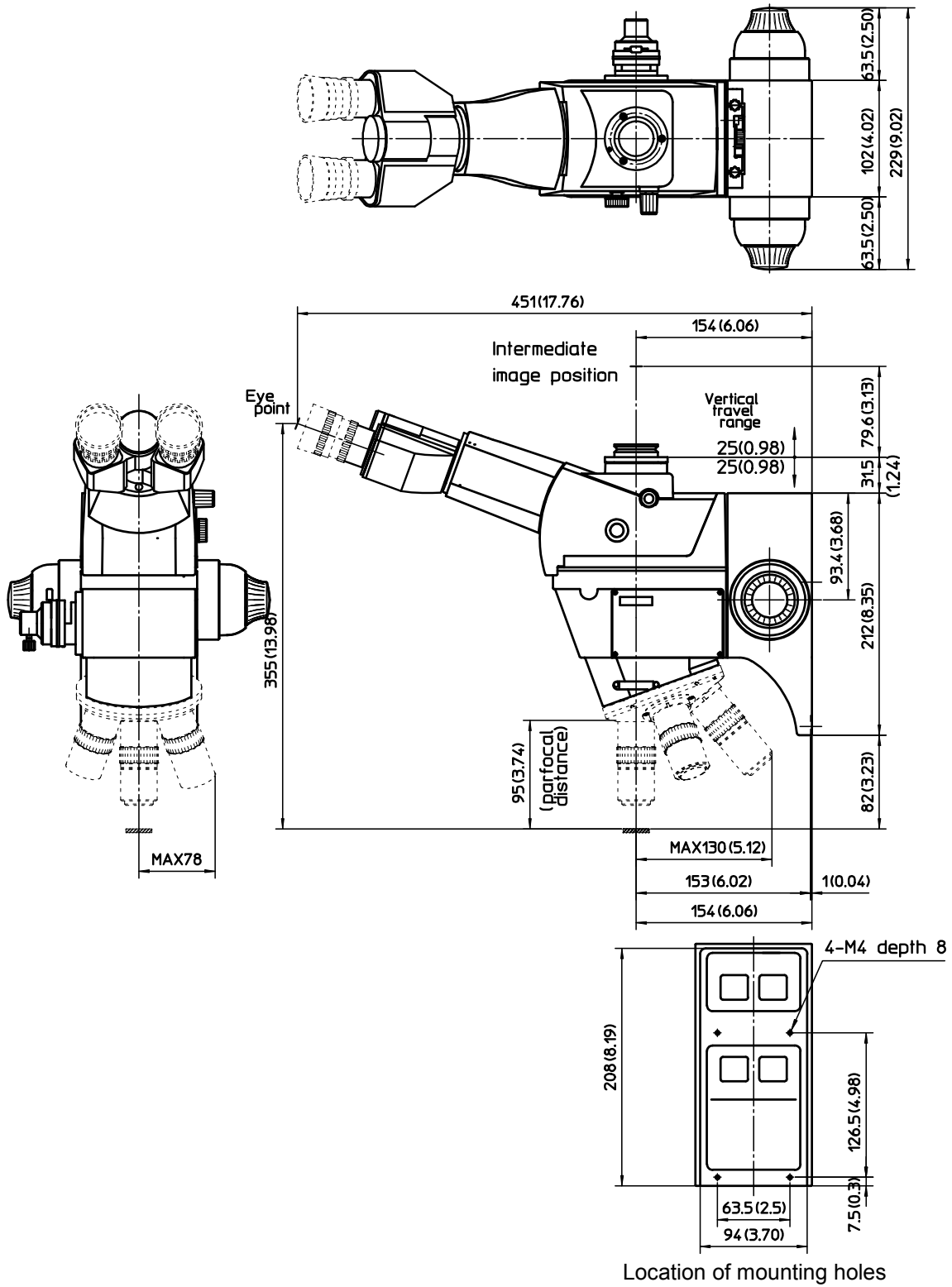
(2) FS70-S

Unit : mm (inch)



(3) FS70-TH

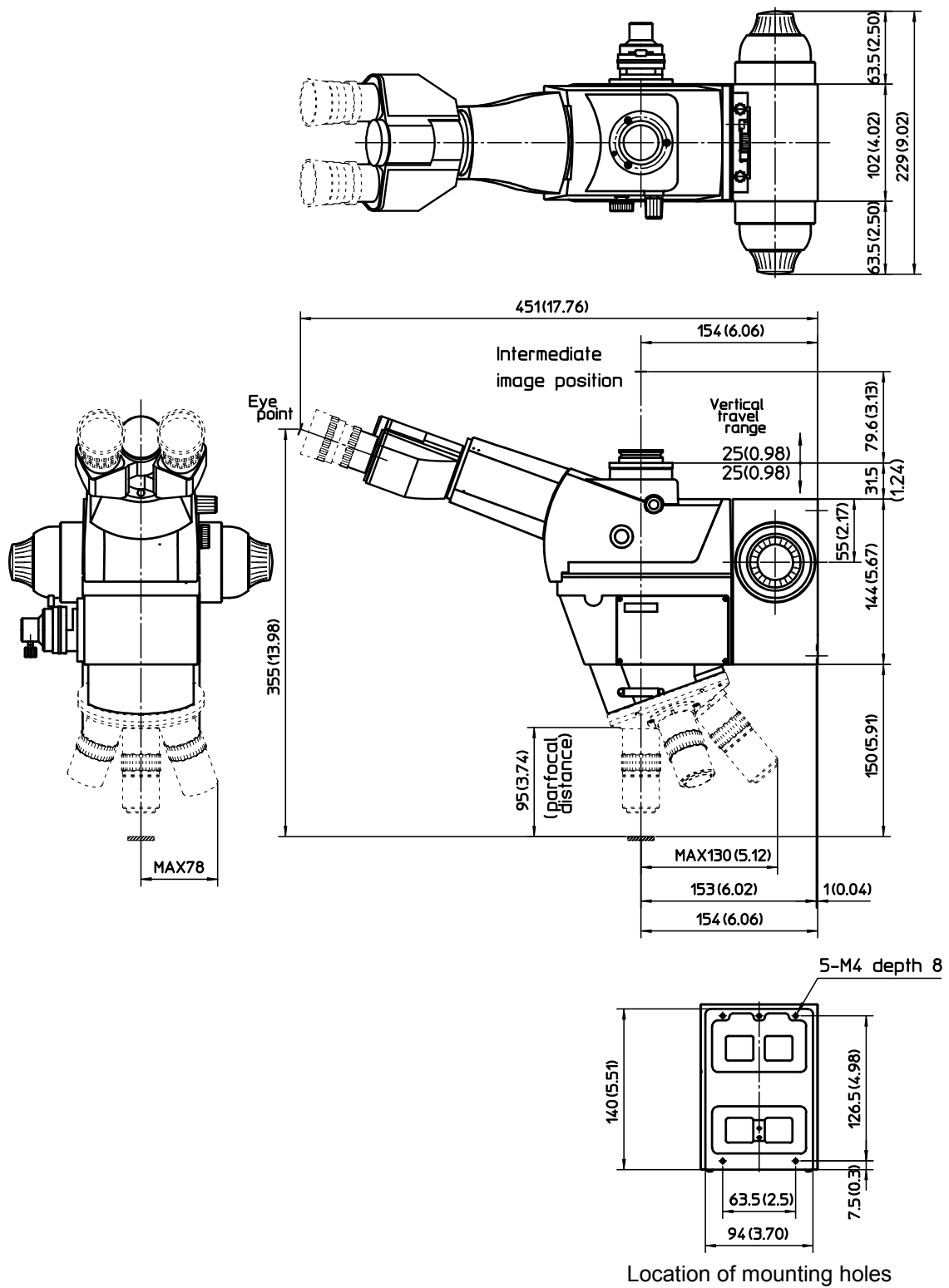
Unit : mm (inch)



6. Specifications

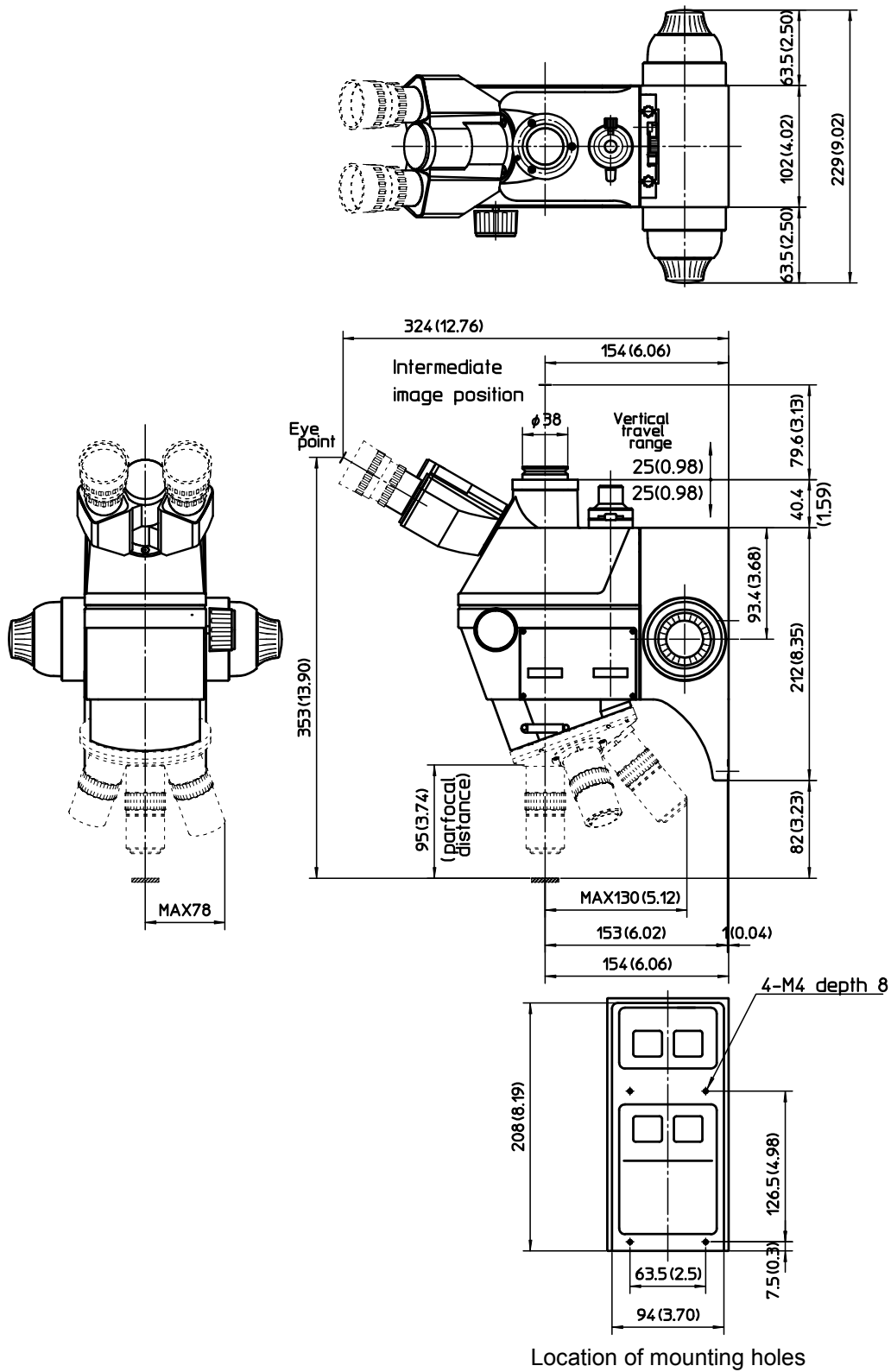
(4) FS70-THS

Unit : mm (inch)



(5) FS70Z

Unit : mm (inch)

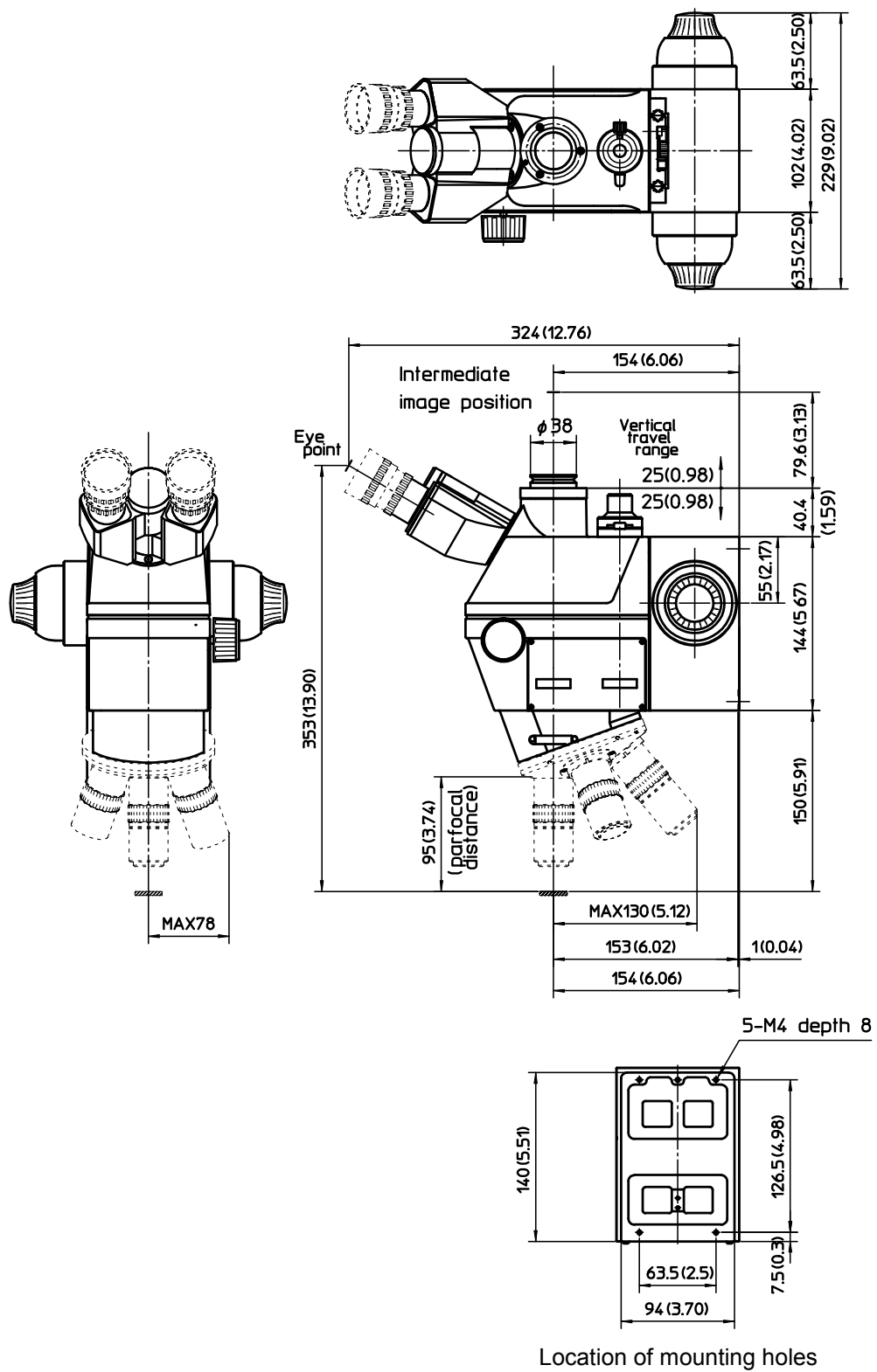


Location of mounting holes

6. Specifications

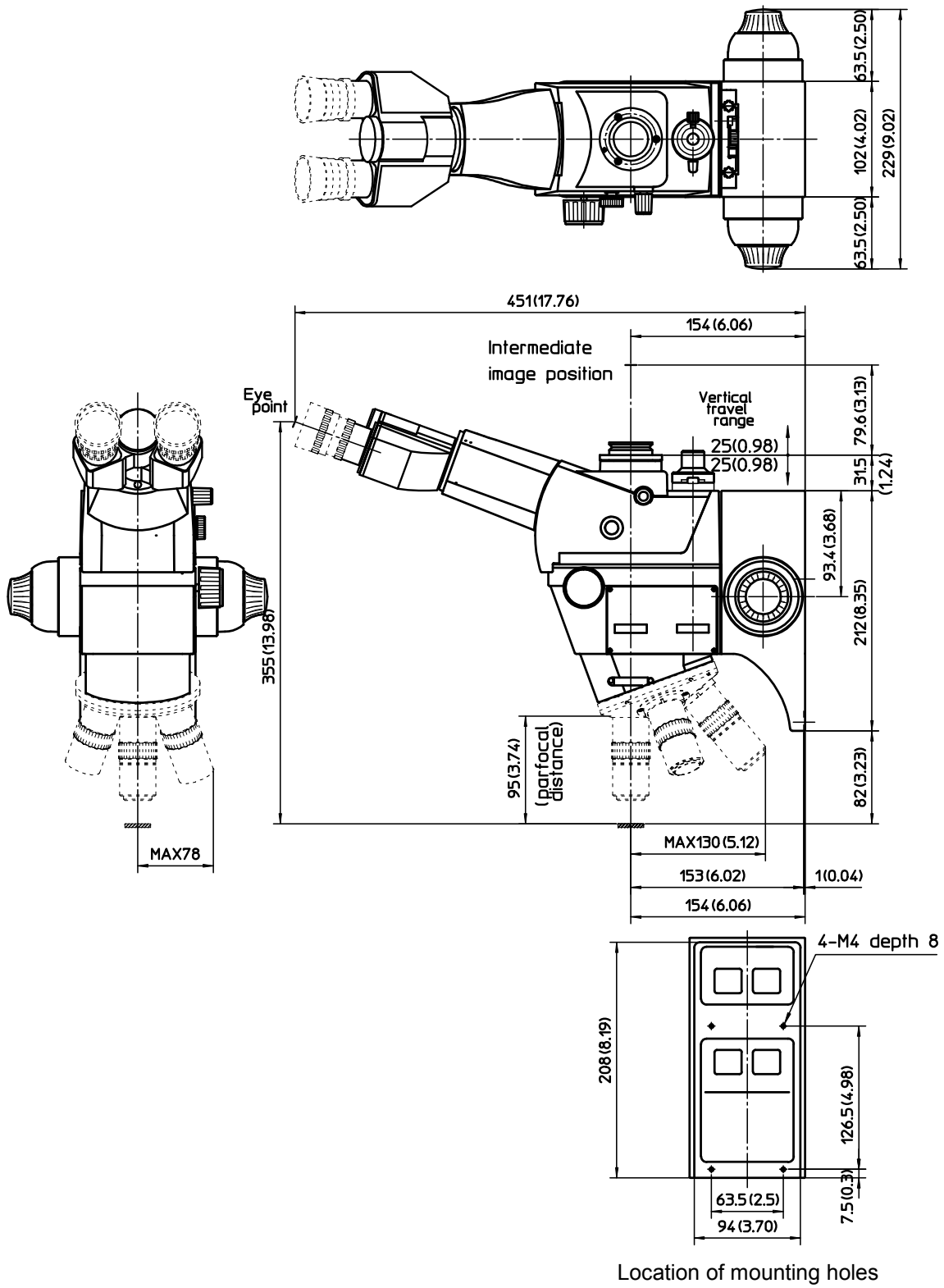
(6) FS70Z-S

Unit : mm (inch)



(7) FS70Z-TH

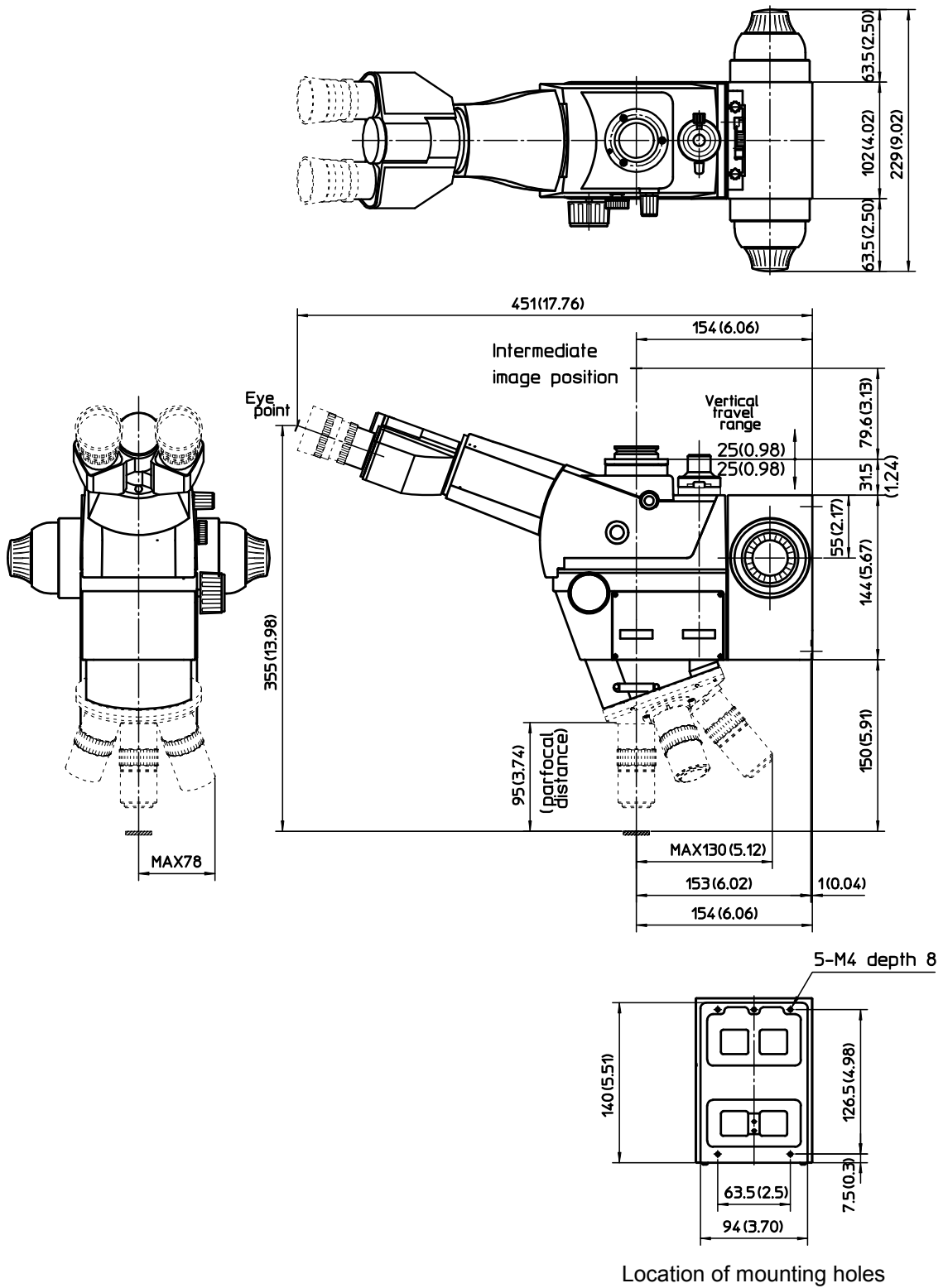
Unit : mm (inch)



6. Specifications

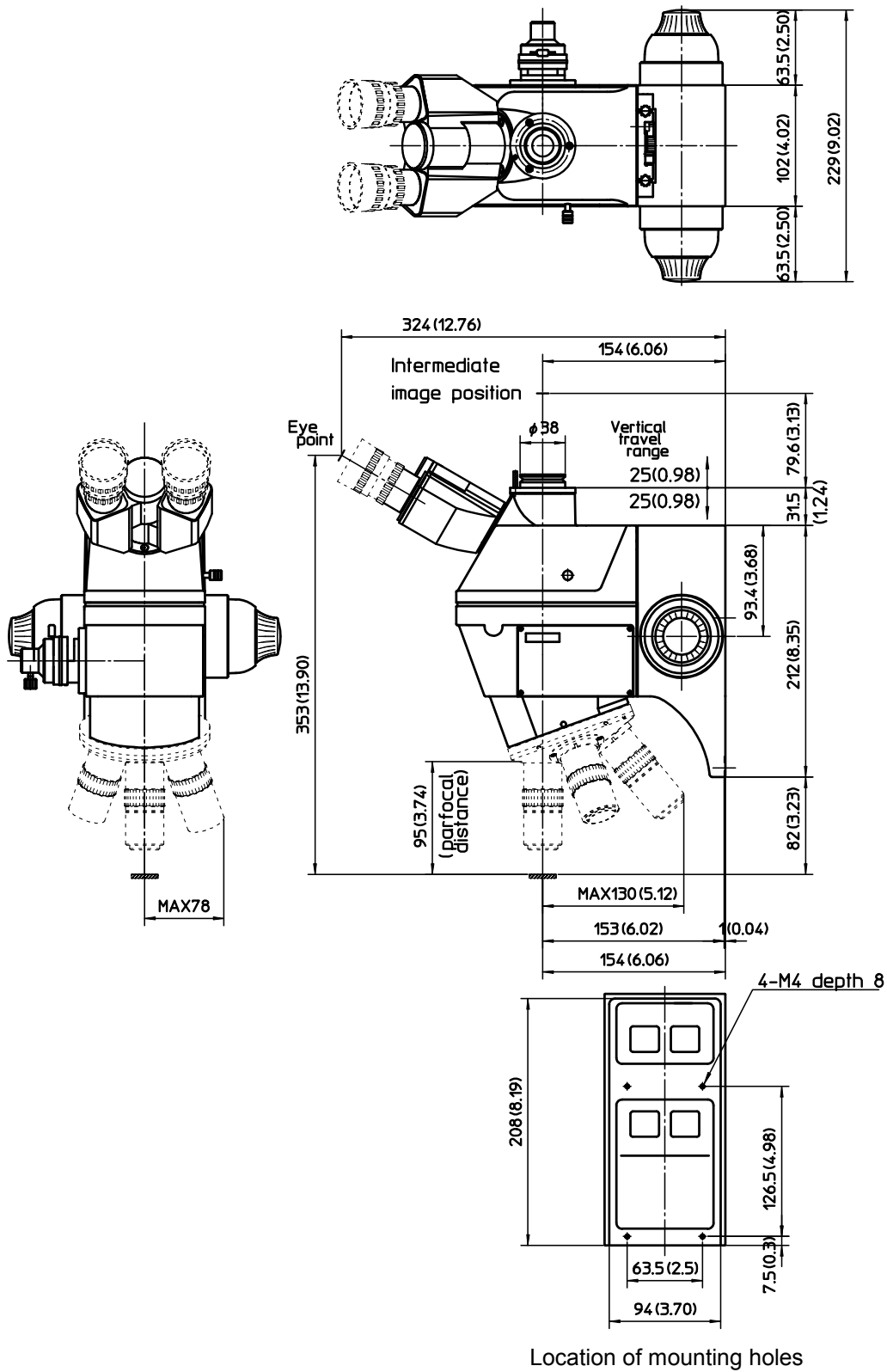
(8) FS70Z-THS

Unit : mm (inch)



(9) FS70L

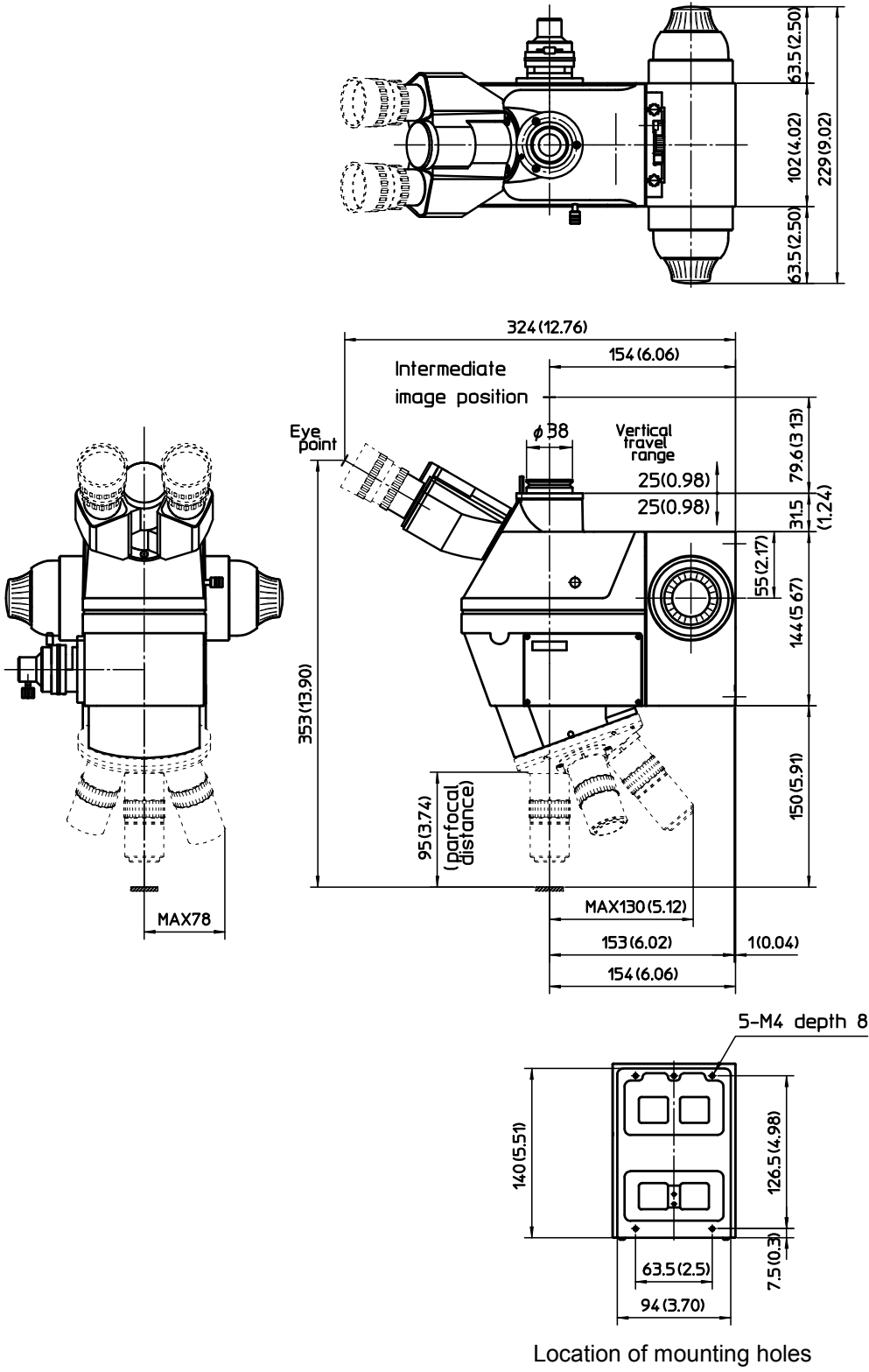
Unit : mm (inch)



Location of mounting holes

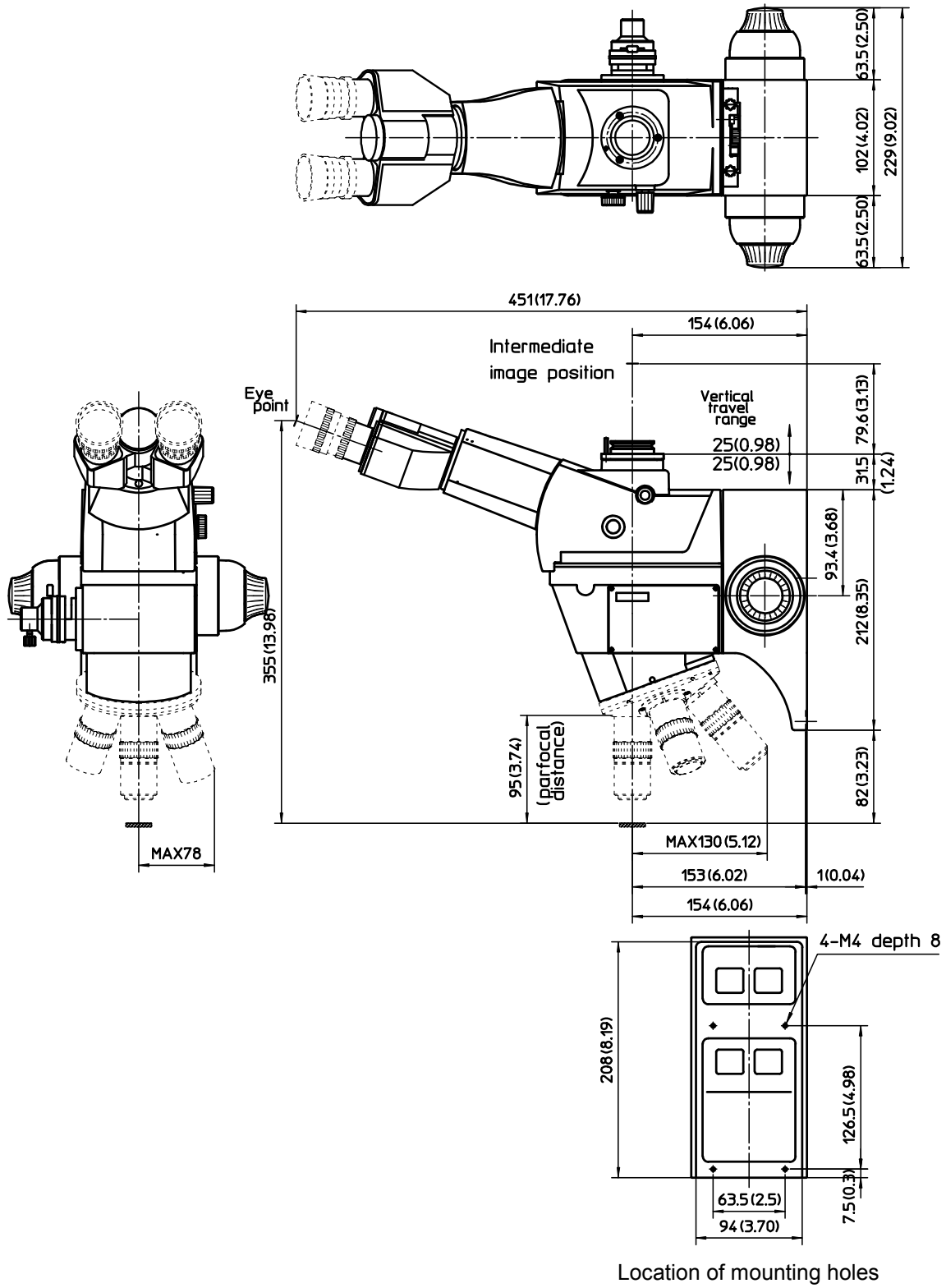
(10) FS70L-S

Unit : mm (inch)



(11) FS70L-TH

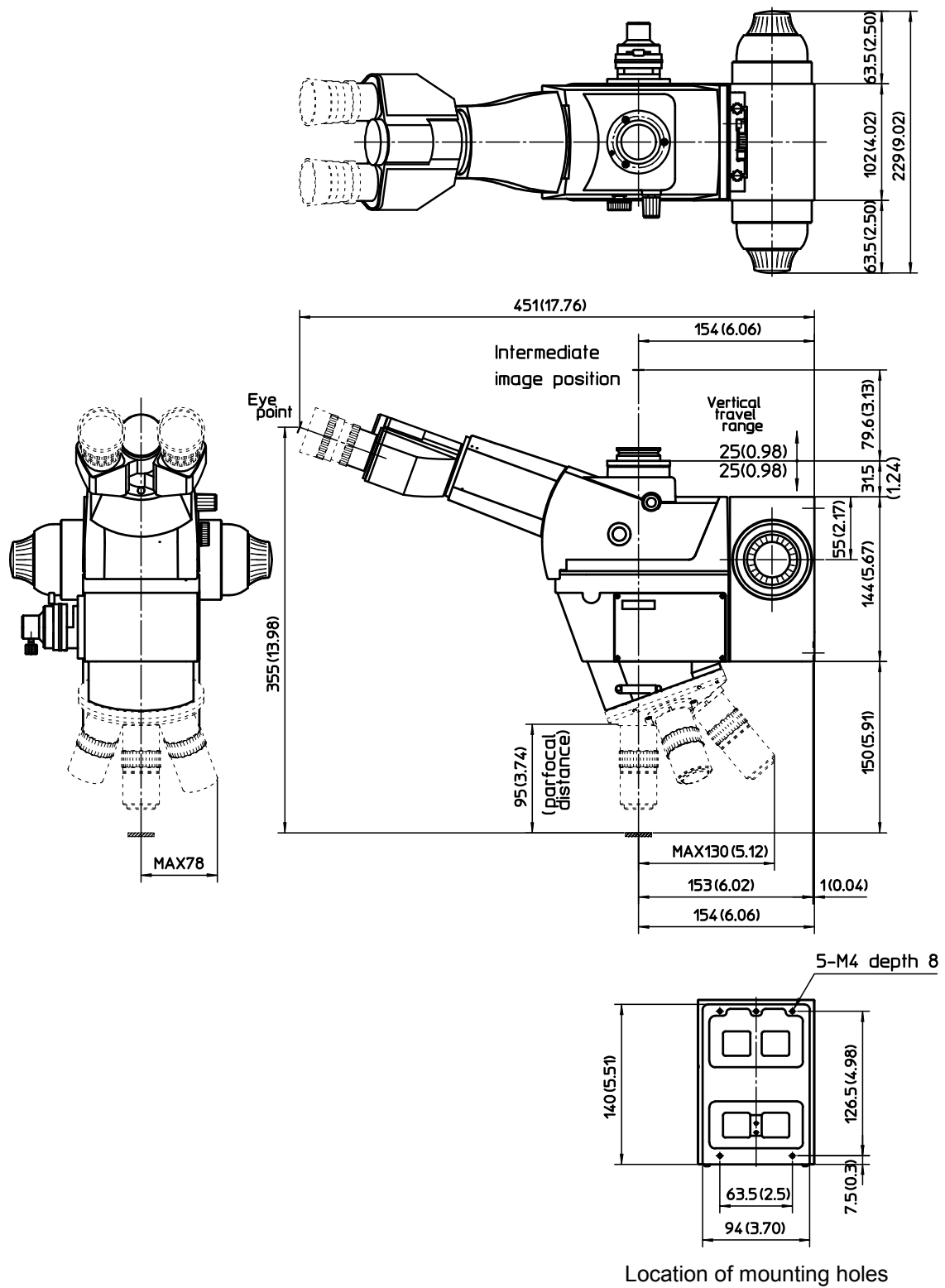
Unit : mm (inch)



6. Specifications

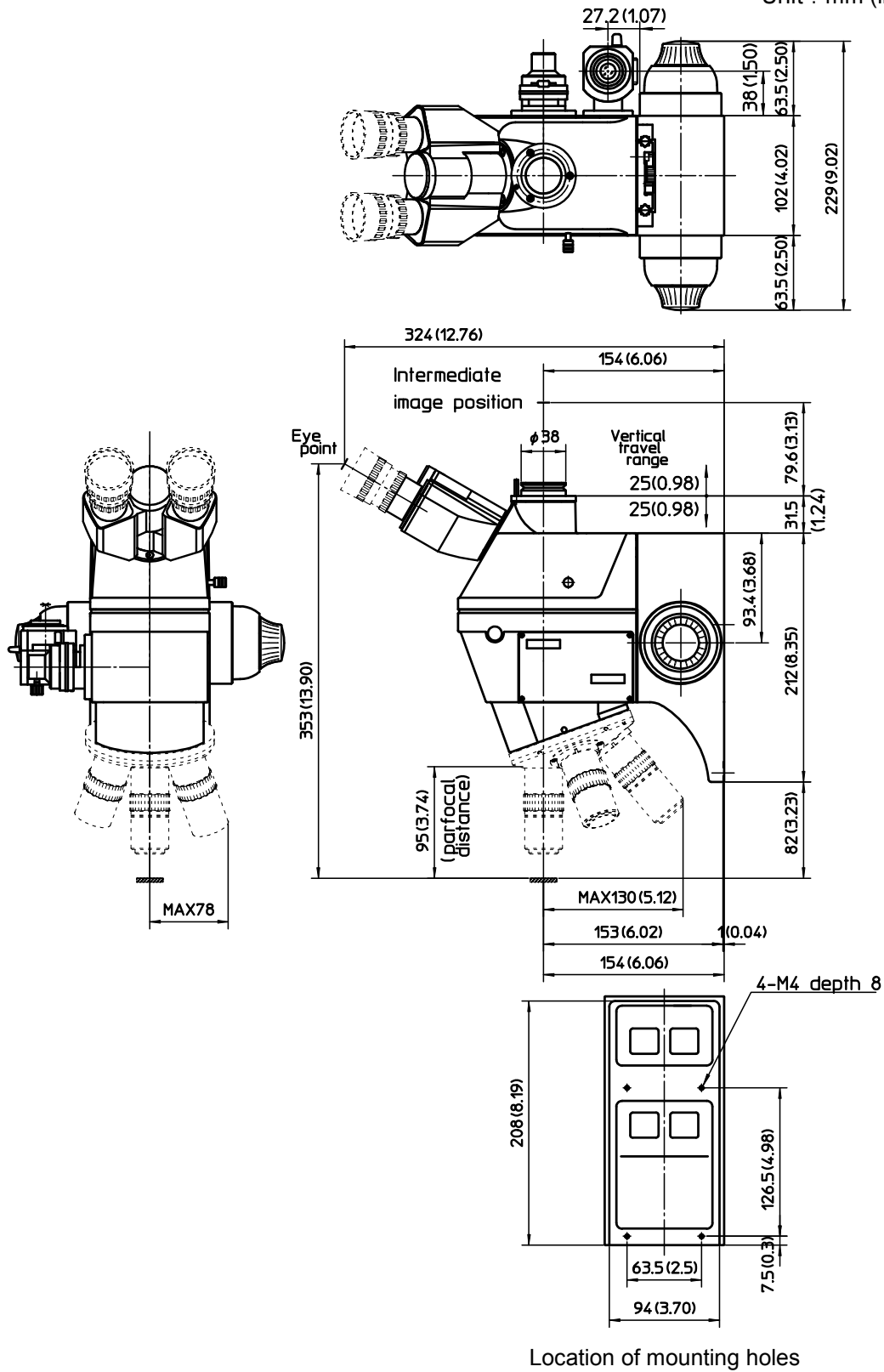
(12) FS70L-THS

Unit : mm (inch)



(13) FS70L4

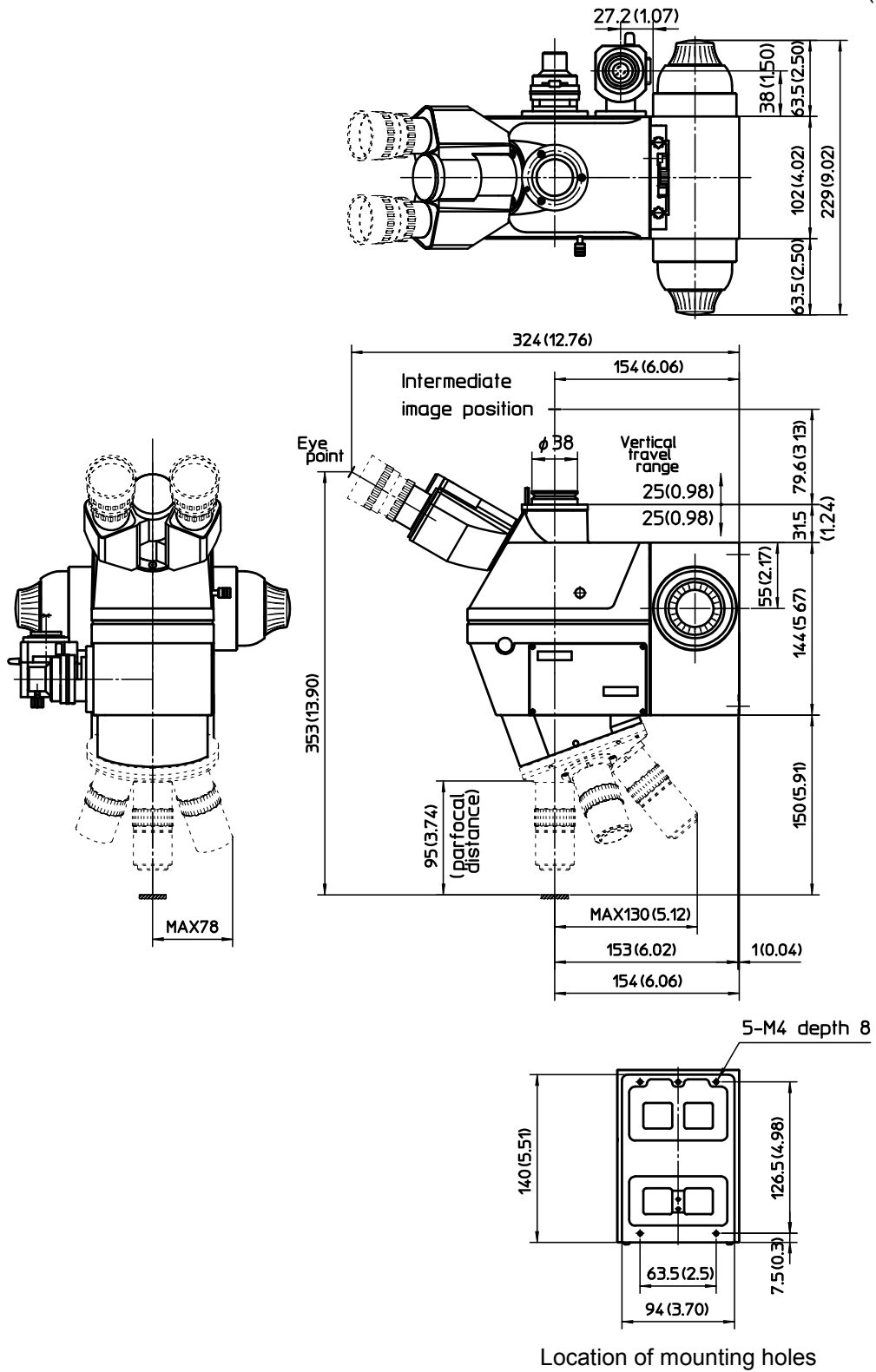
Unit : mm (inch)



6. Specifications

(14) FS70L4-S

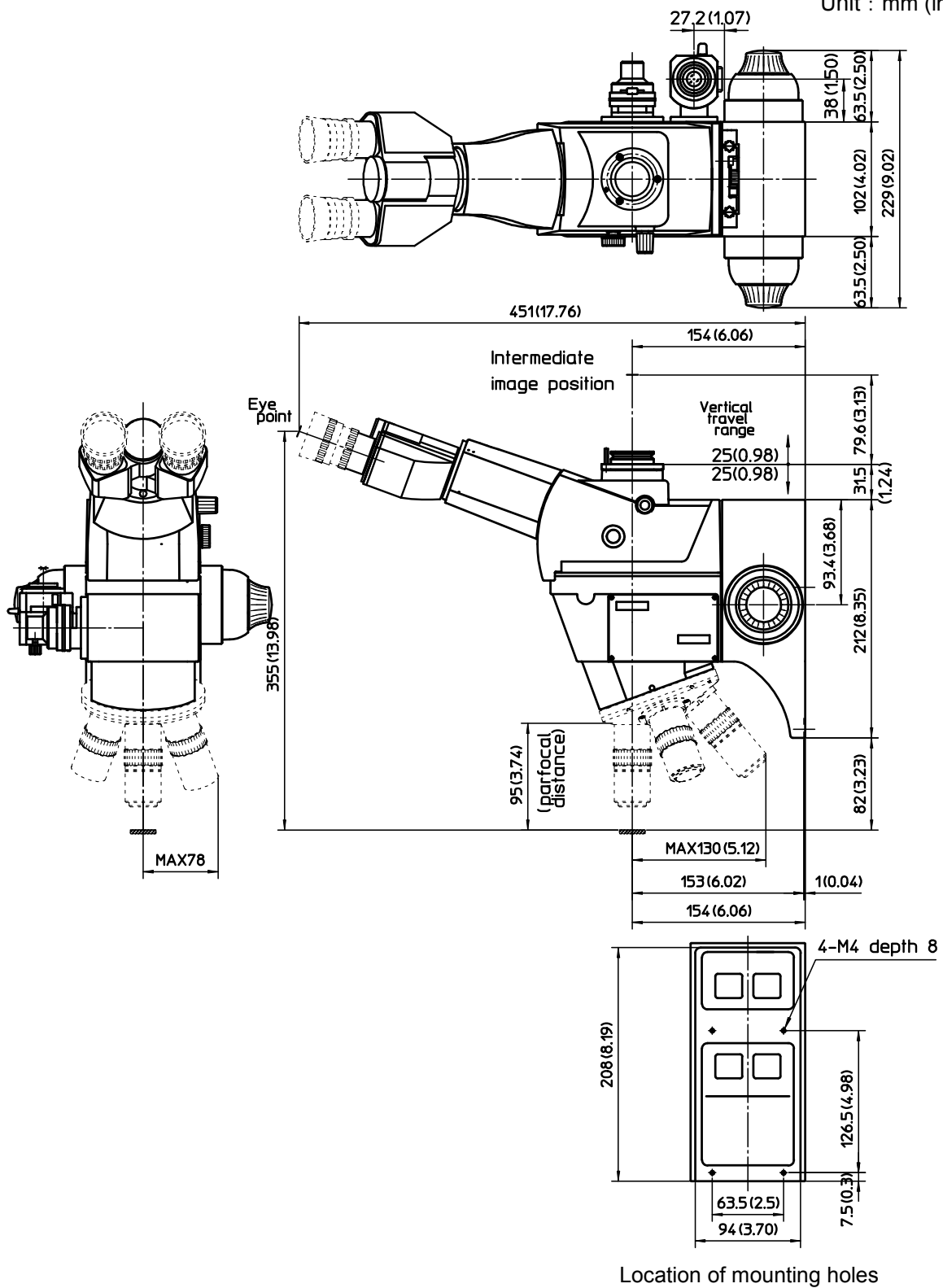
Unit : mm (inch)



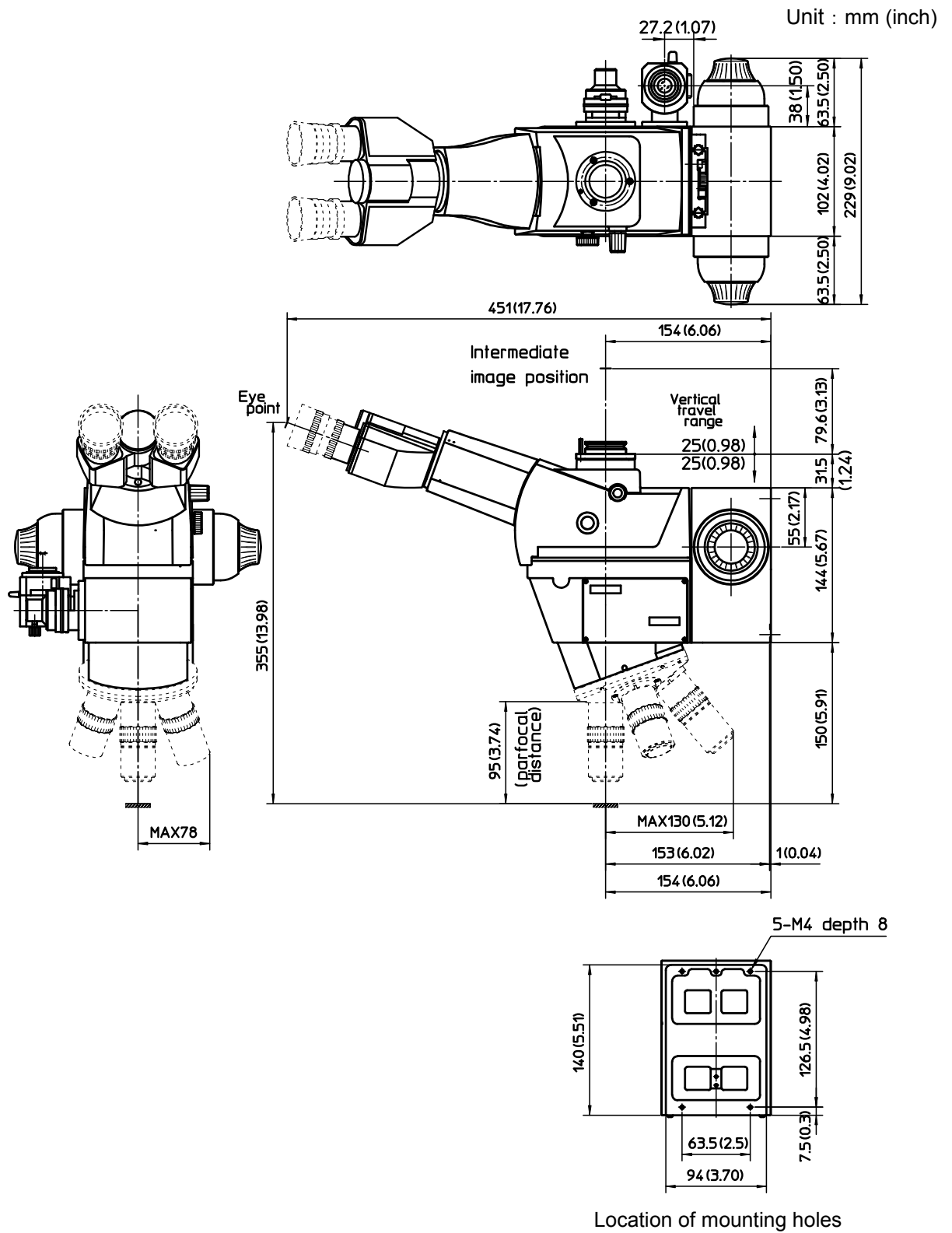
Location of mounting holes

(15) FS70L4-TH

Unit : mm (inch)



(16) FS70L4-THS



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