



Safety Precautions

When using this product, observe the precautions regarding its specifications, functions, and use that are described in this document. Failure to do so may impair the safety of the product.

Before Using This Product

In order to achieve the best performance of this product and to keep the product in its best condition so that it can be used for many years, read this document thoroughly before using this product. After reading, retain it in a safe place.

Precautions regarding Transfers Outside Japan

This product is subject to the Foreign Exchange and Foreign Trade Act of Japan. If you intend to transfer products or technologies from a country other than Japan, please contact Mitutoyo in advance.

Conventions Used in This Document

- Safety reminder conventions warning against potential hazards

NOTICE

Indicates a situation which, if not avoided, may result in property damage.

- Conventions indicating referential information or reference location



Indicates reference location if there is information that should be referred to in this document or an extraneous User's Manual. Example: (Fig. "3. Maintenance")

Precautions for Use

- This product is a reference instrument that is used to measure parallelism or flatness. Do not use it for any purposes other than measuring parallelism or flatness.
- This product is a precision instrument. It must be handled carefully. Be careful not to jolt or apply excessive force to any of its parts during storage or use.
- If this product is jolted or exposed to excessive force, the accuracy of the product may be impaired.
- Before using this product, wipe dirt off of the product and the target measurement surface by referring to Fig. "3. Maintenance".
- It is recommended to use this product in a location with minimal dust, filth, and vibrations. It is also recommended to place this product on a surface plate during use.
- It is recommended to use this product in an environment of around 20 °C where temperature fluctuations are minimal. Avoid using this product in locations directly exposed to drafts of hot air, cool air, or air conditioning.
- Prior to use, be sure to perform sufficient thermal stabilization of this product along with the gage to be measured.

Limited Warranty

This product has been manufactured under strict quality management, but should it develop problems within one year of the date of purchase in normal use, repair shall be performed free of charge. Please contact the agent where you purchased the product or Mitutoyo sales representative.

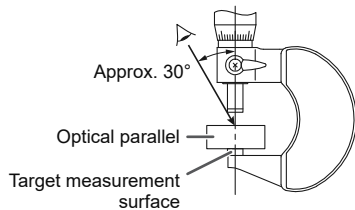
1. Overview

Optical parallels are used to inspect parallelism or flatness by means of optical interference. They are best used for inspecting mirror-finished surfaces of gauges such as micrometers or gauge blocks.

2. Parallelism and Flatness Measurement Employing Interference Fringes

Interference fringes appear in a variety of colors. Perform measurement by focusing on one of those colors. In this document, an explanation is provided by using red interference fringes as an example.

Take a reading at a position that is tilted approx. 30° relative to the axis of the target measurement surface as shown in the figure on the right. If a reading is taken at a position that is at an acute angle to the axis, interference fringes may not be observed.



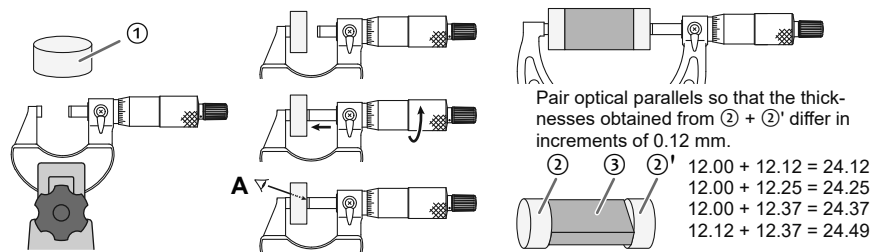
NOTICE

Indicates a situation which, if not avoided, may result in property damage.

Caution should be exercised when pressing the optical parallel against the target measurement surface. Failure to do so risks damaging the measurement surface of the optical parallel.

2.1 Measuring the Parallelism

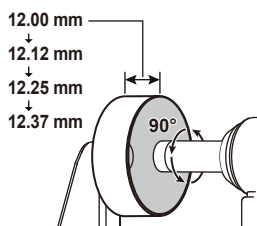
When measuring a micrometer, use the four optical parallels, which differ in thickness by 0.12 mm (equivalent to 1/4 of a full rotation of the spindle), in order from thinnest to thickest to measure the parallelism of the target measurement surface at the four different spindle positions. The thickness is indicated on the side of each optical parallel.



- 1 Clean the optical parallel and the target measurement surface. (Fig. "3. Maintenance")
- 2 Press the optical parallel (1) against the anvil face. For micrometers with a measuring range of 25 mm to 50 mm or more, refer to the above figure on the right.
- 3 Feed the spindle to press it against the optical parallel (1).
- 4 From position A, take a reading of the number of interference fringes on the spindle side. (Fig. "• Example measurements (examples of interference fringe appearance)")
- 5 Use the equation below to obtain the parallelism (P):

$$\text{Parallelism (P) } (\mu\text{m}) = \lambda/2 \times n$$

n = The number of interference fringes that appeared on the spindle side
 $\lambda/2 = 0.32 \mu\text{m}$ (red interference fringes)
 λ = The wavelength of the light being observed (μm)
- 6 Retract the spindle and then replace the optical parallel with the next thickest one.
- 7 While repeating Steps 2 to 6, calculate the flatness of one spindle rotation (performing sub-calculations every 1/4 rotation) by using all four optical parallels. The maximum value is the parallelism of the micrometer.



• Example measurements (examples of interference fringe appearance)

Spindle side *1			
One (0.3 μm) *2	Two (0.6 μm) *2	Three (1 μm) *2	Four (1.3 μm) *2

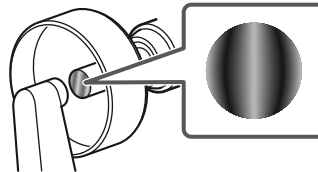
*1: The anvil side is regarded as the reference side. For this reason, the number of interference fringes on that side is not counted.

*2: Each value in parentheses indicates the parallelism of the target measurement surface (red interference fringes).

2.2 Measuring the Flatness

The flatness of the target measurement surface is calculated from either the number or the shape of the interference fringes.

2.2.1 Calculating from the Number of Interference Fringes



$$\text{Flatness (F)} = \lambda/2 \times n (\mu\text{m})$$

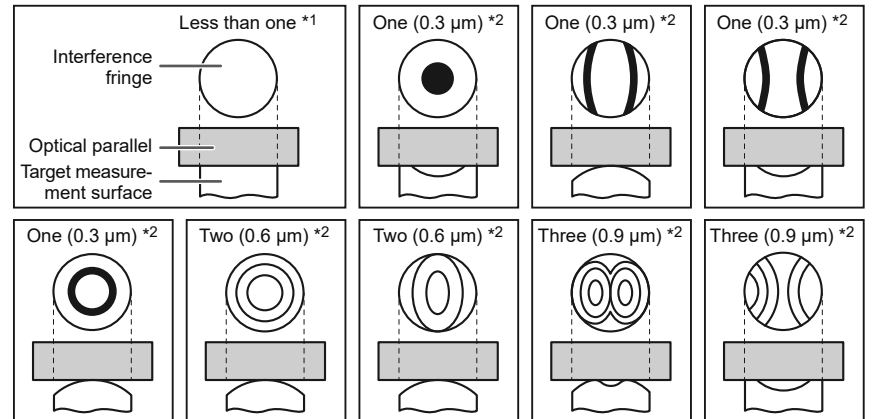
n = The number of interference fringes

$\lambda/2 = 0.32 \mu\text{m}$ (red interference fringes)

λ = The wavelength of the light being observed (μm)

- 1 Clean the optical parallel and the target measurement surface. (Fig. "3. Maintenance")
- 2 Press the optical parallel against the target measurement surface.
- 3 Take a reading of the number of interference fringes. (Fig. "• Example measurements (examples of interference fringe appearance)")
- 4 Use the equation above to calculate the flatness (F).

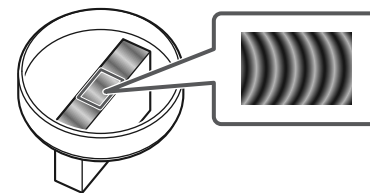
• Example measurements (examples of interference fringe appearance)



*1: When none of the interference fringes is visible, the shape of the interference fringes can be used to obtain the flatness. (Fig. "2.2.2 Calculating from the Shape of the Interference Fringes")

*2: Flatness of the target measurement surface calculated from red interference fringes

2.2.2 Calculating from the Shape of the Interference Fringes



$$\text{Flatness (F) } (\mu\text{m}) = (\lambda/2) \times (b/a)$$

a = Distance between interference fringe centers (mm)

b = Extent of interference fringe curvature (mm)

$\lambda/2 = 0.32 \mu\text{m}$ (red interference fringes)

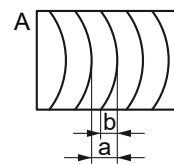
λ = The wavelength of the light being observed (μm)

- 1 Clean the optical parallel and the target measurement surface. (Fig. "3. Maintenance")
- 2 Press the optical parallel against the target measurement surface.
- 3 Lightly push one side of the optical parallel with your finger.

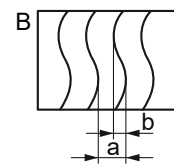
» Interference fringes appear when the optical parallel is tilted.
 $\text{Gap (t)} = n \times \lambda/2$
n: The number of interference fringes
Angle (α) $\approx 180/\pi \times \tan (t/L)$
L: The length of the target measurement surface

Example: When five red interference fringes appear on the micrometer spindle ($\phi 6.3 \text{ mm}$): t = approx. 1.6 μm , α = approx. 0.02°

- 4 Calculate the ratio of a to b as shown in the figures below (A and B) and then use the equation above to obtain the flatness (F).



The ratio of a to b is 5 : 3.
 $F = 0.32 \times (3/5) (\mu\text{m})$



The ratio of a to b is 5 : 2.
 $F = 0.32 \times (2/5) (\mu\text{m})$

3. Maintenance

In order to achieve the best performance of this product and to use the product safely for many years, perform cleaning in accordance with the following items.

- Dust: Brush it off with a lens cleaning brush or a soft ink brush, or wipe it off with gauze.
- Fingerprints or oil stains: Wipe them off with lens paper, or with gauze dipped in a small amount of lens cleaner.

4. Specifications

Code No.	157-903	157-904	157-901	157-902
Model No.	OP-25	OP-50	OP-1 IN	OP-2 IN
Parallelism*	0.2 μm		0.000008 in	
Flatness*	0.1 μm		0.000004 in	
Diameter	30 mm		1.18 in	
Thickness	12.00 mm, 12.12 mm, 12.25 mm, 12.37 mm	25.00 mm, 25.12 mm, 25.25 mm, 25.37 mm	0.5000 in, 0.5062 in, 0.5125 in, 0.5187 in	1.0000 in, 1.0062 in, 1.0125 in, 1.0187 in

*: Excluding the area within a distance of 2 mm from the circumference of the measurement surface