

INDIA OPTEL LIMITED

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Project Report

Unit - E28 , Metrological Service Department (MSD)

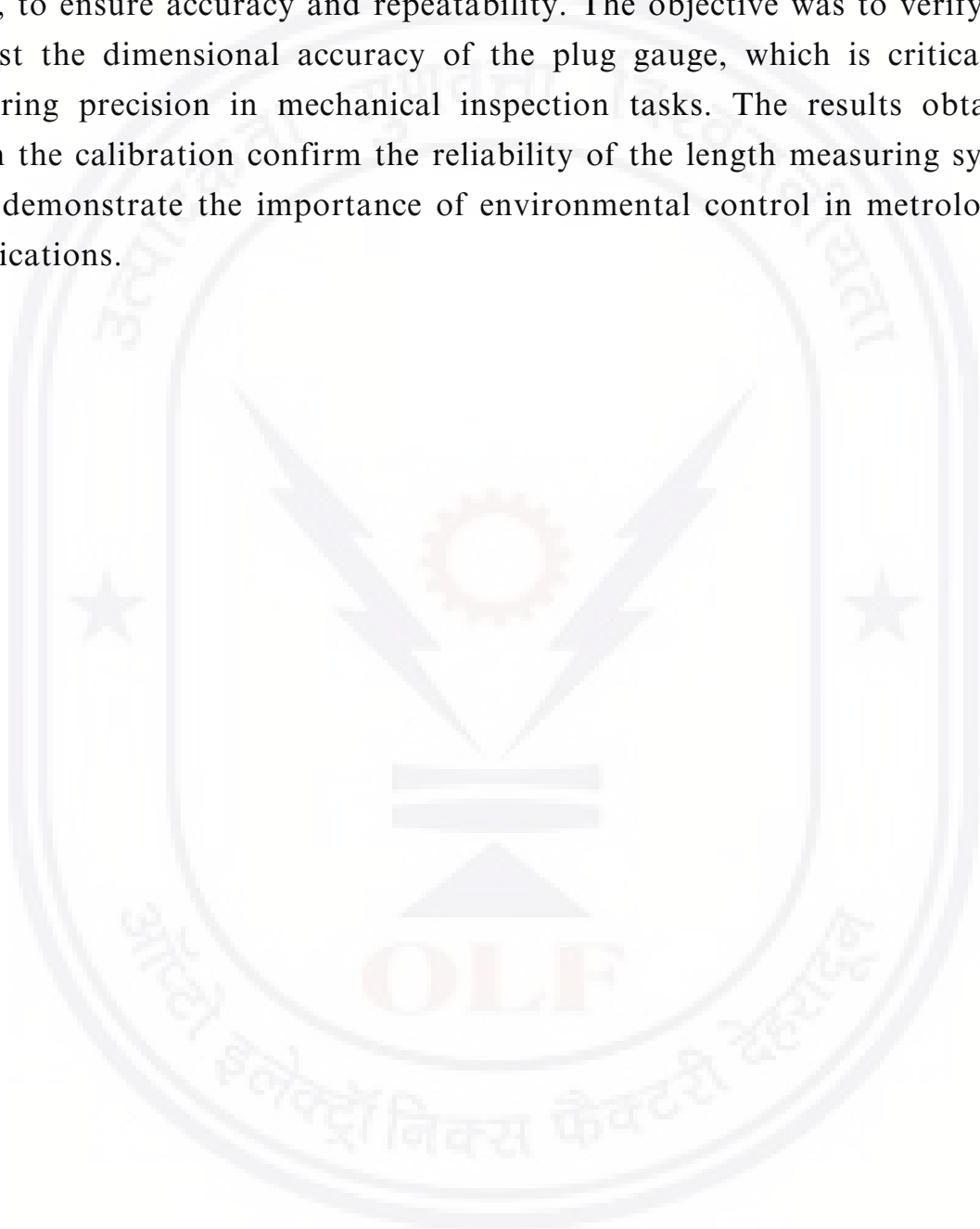
Topic - Calibration of Dial Gauge (Plunger) Presented

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Abstract

This project focuses on the calibration of a plunger-type dial gauge using a high-precision length measuring machine with a least count of 0.0001 mm and a measurement range of up to 300 mm. The calibration process was carried out under controlled environmental conditions, specifically at a room temperature of $22\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ and relative humidity between 40% and 60%, to ensure accuracy and repeatability. The objective was to verify and adjust the dimensional accuracy of the plug gauge, which is critical for ensuring precision in mechanical inspection tasks. The results obtained from the calibration confirm the reliability of the length measuring system and demonstrate the importance of environmental control in metrological applications.



Introduction

A **dial gauge**, also known as a dial indicator, is a precision measuring instrument used to measure small linear distances or displacements with high accuracy. It is widely used in mechanical, manufacturing, and metrology applications to check variations in tolerance or to ensure precise alignment and positioning of components. The key feature of a dial gauge is its dial display, which amplifies small movements of a plunger (or spindle) into readable values on a graduated circular scale. The mechanism inside the gauge typically uses a system of gears and levers to magnify the displacement of the plunger, allowing even minute measurements (as small as 0.001 mm in some models) to be easily read by the user.

Dial gauges are available in various types, such as:

Plunger-type (standard dial indicators) – where the movement is along a single axis.

Lever-type (test indicators) – which use a pivoting arm instead of a plunger.

Digital dial indicators – providing electronic readouts for more precise readings and data logging.

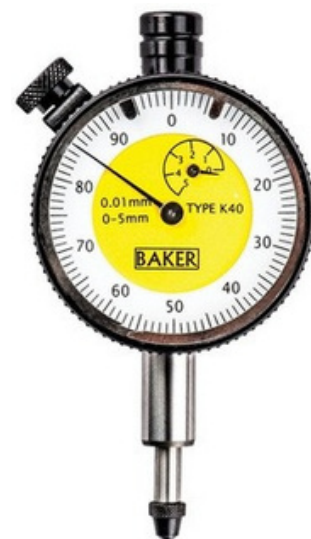
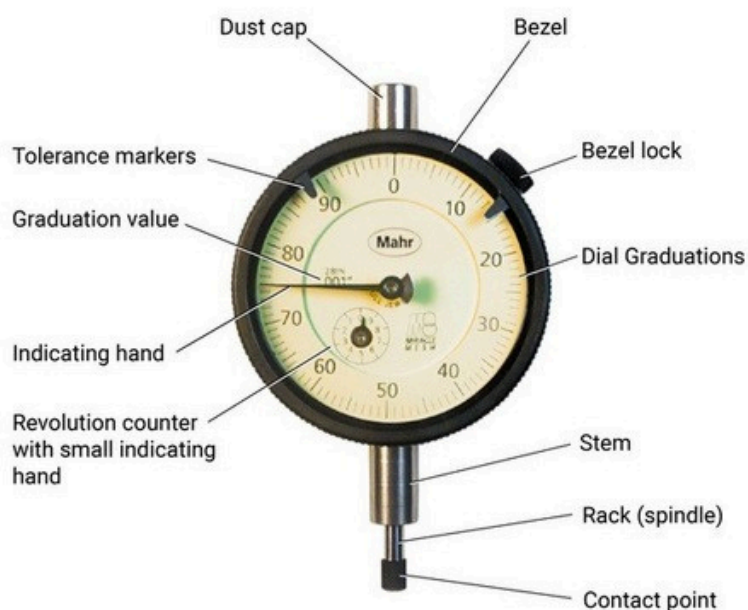


fig : Dial Indicator Plunger type

Applications of Dial Gauge

Dial gauges are versatile instruments used across a range of industries and disciplines. Common applications include:

- **Alignment Checking**
 - Ensuring the straightness and parallelism of machine beds, shafts, and guideways.
 - Aligning tailstocks with spindles in lathes.
- **Runout Measurement**
 - Checking the circularity and eccentricity of rotating parts such as shafts and wheels.
 - Measuring the deviation of rotating components from a true circular path.
- **Flatness and Parallelism Testing**
 - Verifying the flatness of surfaces such as machine tables and reference plates.
 - Ensuring two surfaces are parallel using a surface plate and height gauge.
- **Tool Setup in CNC and Conventional Machines**
 - Precise setting of tool positions.
 - Detecting wear or movement in machine components.
- **Comparative Measurements**
 - Comparing a part against a master or standard component.
 - Detecting dimensional deviations during inspection.
- **Metrology and Calibration Tasks**
 - Used in calibration laboratories to assess the accuracy of gauges, fixtures, and measuring setups.
 - Employed in conjunction with slip gauges, gauge blocks, and coordinate measuring machines (CMMs).
- **Deflection and Deformation Studies**
 - Measuring small deflections in beams, machine frames, or other components under load.

A **Length Measuring Machine (LMM)** is a high-precision metrological instrument designed to measure or calibrate the length, linear displacement, or dimensions of mechanical components with extremely fine resolution. It plays a critical role in dimensional metrology where high accuracy and traceability to national/international standards are required. The particular machine used in this project has a least count of 0.0001 mm (0.1 μm) and a measurement range of 300 mm, making it suitable for both small- and medium- sized precision components. Such machines are commonly found in calibration laboratories, standards rooms, and high-precision manufacturing environments. Key Features:

- **High Precision:** Capable of resolving minute length variations with sub-micron accuracy.
- **Long Measurement Range:** With a range of 300 mm, it accommodates a variety of gauges and components.
- **Linear Guide System:** Ensures smooth and precise movement of the measuring carriage.
- **Digital Display or Comparator Head:** For accurate and repeatable readouts.
- **Stable Base and Support Fixtures:** Made from low-expansion materials (e.g., granite) to minimize thermal and mechanical distortions.

A Length Measuring Machine is used for high-precision calibration of gauges, dial indicators, and precision components. It ensures traceable measurements in metrology labs, toolrooms, and manufacturing industries, especially in aerospace, automotive, and quality control environments where sub-micron accuracy is essential.



fig : LMM with DRM

Aim :

To calibrate a plunger-type dial gauge using a high-precision length measuring machine with a range of 300 mm and a least count of 0.0001 mm, under controlled environmental conditions (ambient temperature: $22\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$, relative humidity: 40– 60%), in order to determine the accuracy and performance of the dial gauge.

Specifications :

Nomenclature	Dial Indicator plunger type
User section	OPT.I
Instrument code	2/27/20/010
Least count , range	.01 mm , 0 - 10 mm
Standardized	LMM (LC - .0001mm , range - 300mm)
Room Temperature	23.55 $^{\circ}\text{C}$
Humidity	66%

Procedure

1.Preparation and Setup

- Ensure that the length measuring machine is clean, level, and calibrated.
- Allow both the dial gauge and the measuring machine to stabilize in the laboratory environment for at least 2 hours.
- Record the ambient conditions (temperature and relative humidity) and ensure they are within the specified range ($22\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$, RH: 40–60%).

2.Mounting the Dial Gauge

- Secure the plunger-type dial gauge on the fixture provided on the length measuring machine.
- Align the dial gauge vertically to ensure the plunger movement is in line with the axis of the measuring probe.

3.Zeroing the Instrument

- Set the reference zero on the length measuring machine.
- Adjust the dial gauge to zero when the plunger is in its reference (fully retracted) position.

4.Stepwise Measurement

- At each step, record the corresponding reading from both the length measuring machine and the dial gauge.

5.Repeatability Check

- Repeat the measurements in forward and reverse directions to check for hysteresis or backlash.
- Perform at least three trials to ensure repeatability and consistency.

5.Data Analysis

- Compare the dial gauge readings with the reference readings from the length measuring machine.
- Calculate errors and deviations at each point

Accuracy parameters:

Parameters	limits of error
any 1/10 revolution	.005mm
over any 1 revolution	.01mm
any 2 revolution	.015mm
any larger interval upto	.02mm
Repeatability	0.002

Observation table :

S.No	Division of dial	deviation in microns						Error (max)
		F	R	F	R	F	R	
1	0	sct	1.1	0.5	0.7	0.2	0.7	1.1
2	0.01	0.7	1.3	0.6	1.1	0.5	1.1	1.3
3	0.02	0	0.4	0	0.3	0.3	0.1	0.4
4	0.03	1.2	1.3	0.4	1.4	0.5	1.1	1.4
5	0.04	0.4	0	1.1	0	-0.1	-0.3	1.4
6	0.05	0.7	0.6	0	0.7	0.6	0.3	0.7
7	0.06	-0.1	0	-0.2	-0.9	-0.1	-0.3	0.9
8	0.07	1.2	1.1	0.8	0.4	0.3	0.8	1.2
9	0.08	2.2	0.5	1.2	0.5	0.2	0.4	2.2
10	0.09	1.7	1.5	1.4	1.7	1.2	1.3	1.7
11	1	4.8	3.9	4.2	3.5	4.9	3.9	4.9
12	2	3.6	3.4	3.7	3.5	3.4	3.4	3.7
13	4	3.6	3.6	4.6	3.3	7.5	3.5	7.5
14	8	2.4	0.4	0.4	0.8	2.7	0.4	2.7
15	10	6.6	7.3	5.8	5.8	7.1	7.7	7.7

Results and Conclusion:

Deviation (microns) :

max - 7.7

min - 0

Total error (microns):

max - 7.7

min - 0.4

As our values are within the accuracy parameters our Dial gauge is valid.

Date of Calibration : 21/06/25

Validity until : 21/06/26

Inference:

The calibration of the plunger-type dial gauge showed that it performs accurately and consistently, staying well within the expected metrological limits. The small deviations recorded during the test indicate that the instrument doesn't suffer from any significant errors, and its readings can be trusted.

There was only minimal difference between forward and reverse readings, which suggests that the dial gauge's internal mechanism is in good condition without any noticeable backlash or mechanical play.

Using a high-precision length measuring machine with a least count of 0.0001 mm made it possible to detect even the tiniest variations, giving us a high level of confidence in the calibration results.

Based on this, the dial gauge is certified to be reliable and is fit for precise measurements and inspections for the next year (until 21/06/26) .

thank you
THE END