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Indian Standard

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SPECIFICATION FOR PLUNGER TYPE DIAL GAUGES

(First Revision)

1. Scope — Covers the dimensional and functional characteristics of the plunger type dial gauge reading to 0·01 mm and 0·002 mm.

2. Terminology

2.1 *Dial Gauge* — A measuring instrument in which the displacements of a plunger are transmitted by suitable mechanical means to a pointer which rotates in front of a circular dial, graduated in equal divisions over the whole of its circumference. It may also be provided with revolution counting device in which an auxiliary pointer rotates in front of a scale which indicates the total number of revolution of the main pointer and also the linear displacement of the plunger.

2.2 *Measuring Range* — The nominal working travel of the spindle.

2.3 *Scale Interval* — The value of measured quantity which the scale is graduated to indicate.

2.4 *Sensitivity* — A property of a measuring instrument which characterises the ability to respond to small changes of the quantity measured.

Note — This property will also include any hysteresis band of the instrument, if the instrument is subjected to a reversal of the direction of movement of the plunger.

2.5 *Hysteresis* — That property of a measuring instrument, whereby it gives different indications, or responses, for the same value of the measured quantity, according to whether that value has been reached by a continuously increasing change or by a continuously decreasing change of that quantity.

2.6 *Repeatabily* — Repeatability is defined as the ability of a dial gauge to repeat its readings for a given measured length under all normal conditions of use.

2.6.1 Normal conditions of use are as follows:

a) Lowering the plunger several times in succession, at various speeds, into a fixed plate of hard material which is as non-deformable as possible;

b) Moving the same part of the plate or cylinder under the contact point of the plunger, in any direction in a plane perpendicular to the axis of the plunger;

c) Measuring small movements, of the order of 0·025 mm for 0·01 mm and 0·004 mm for 0·002 mm dial gauges; and

d) Bringing the pointer slowly over the same division of the scale several times, first in one direction and then in the other.

2.7 *Calibration* — All the operations for the purpose of determining the values of the errors of a measuring instrument.

Note — Calibration provides typically a chart giving the values of the measured quantities in terms of the established scale unit of the instrument (*see* Appendix A).

2.8 *Reference Temperature* — All measurements for the accuracy of performance given in this standard shall be referred to the reference temperature of 20°C.

3. Nomenclature — The nomenclature of different parts and general dimensions of the dial gauge shall be as shown in Fig. 1.

Adopted 27 January 1983

Gr 4

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Engineering Metrology Sectional Committee, EDC 43; and Precision Measuring Equipment Subcommittee, EDC 43 : 2
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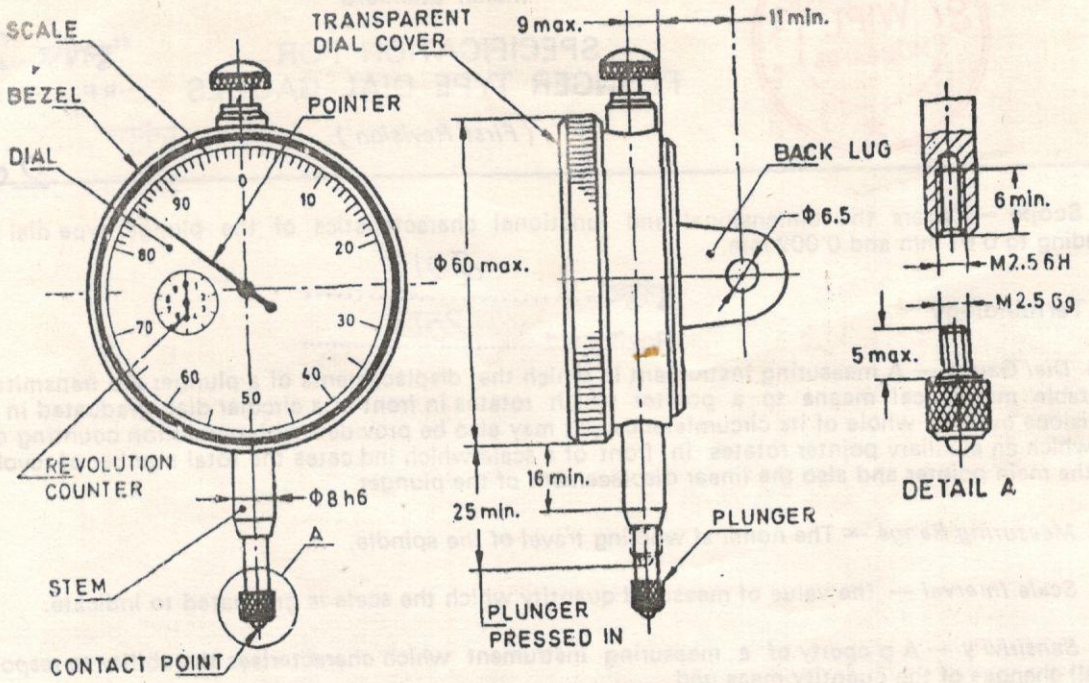


All dimensions in millimetres

FIG. 1 NOMENCLATURE AND DIMENSIONS FOR DIAL GAUGE

4. Design Features

4.1 *General* — The general design and workmanship shall be such that the performance of the dial gauge meet the requirements of the specification under all ordinary methods of operation.

4.2 *Dial*

4.2.1 The dial shall be graduated with sharp lines which contrast with the background permitting ease of reading. The interval between graduations shall not be less than 1 mm.

4.2.2 The width of the scale marks shall be uniform and shall not be less than 0·15 mm and not more than 0·25 mm.

4.2.2.1 For dial gauges reading to 0·01 mm, every tenth division shall be indicated by a numbered longer line and every fifth division line shall be slightly shorter than the tenth division line but longer than the unit division line.

4.2.2.2 For dial gauges reading to 0·002 mm every fifty scale mark shall be indicated by a longer line and shall be numbered.

4.2.3 The length of the visible portion of the scale marks indicating each scale division shall be approximately equal to the width of that division.

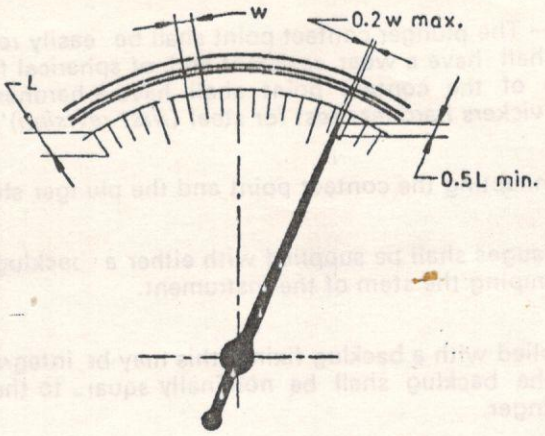
4.2.4 The scale interval shall be indicated by the dimension and the unit (mm).

4.2.5 If black and other coloured (for counter rotating indication) numbers are adopted, then the black numbers on the scale shall be arranged so that they increase in the clock-wise direction.

4.3 *Pointer*

4.3.1 *General* — The pointer shall move in the clockwise direction when the plunger is pressed. The pointer shall be attached to its spindle in such a manner that there shall be no relative movement between the spindle and the pointer when the spindle is subjected to rapid acceleration or deceleration (as, for example, in the event of the plunger being suddenly released and its motion arrested by a fixed stop).

4.3.2 *Width of the pointer* — The width of that portion of the pointer immediately over the scale shall not exceed one-fifth of the width of one scale division and shall be of approximately the same width as the scale mark (*see* Fig. 2).



Width of Scale Marks	=	0·25 mm Max. 0·15 mm Min.
W	=	1 mm Min.
L	=	1·5 w

FIG. 2 PROPORTIONS FOR POINTER AND GRADUATIONS

4.3.3 *Length of the pointer* — The length of the pointer shall be such that its tip lies approximately over the centre of the length of the shortest scale mark (*see* Fig. 2).

4.3.4 *Parallax error* — To reduce parallax errors in reading the instrument, the pointer tip shall be as close to the scale as practicable.

4.3.5 *Free position of the pointer* — When the plunger is in the position of rest and the zero mark on the dial is in the 12 O'clock position the pointer should lie between 9 O'clock and 11 O'clock position (*see* Fig. 3).

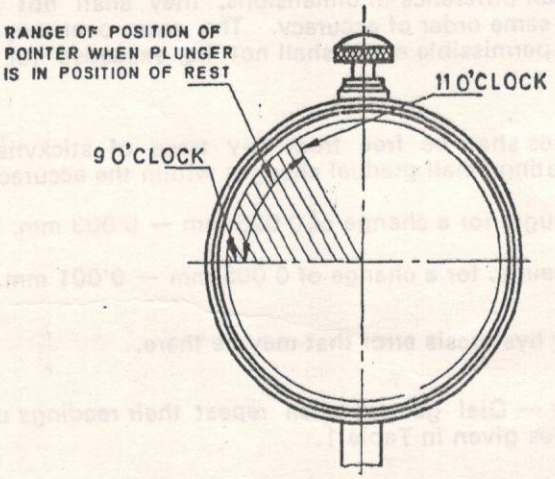


FIG. 3 FREE POSITION OF POINTER

4.3.6 An over-travel of minimum 1/10th revolution beyond the range of indication shall be obtained.

4.3.6.1 The pre-travel and over-travel are not included in the range of indication.

4.4 *Revolution Counter* — Revolution counter shall be provided in all the dial gauges indicating beyond one revolution.

4.5 *Plunger* — Plunger shall have free movement in bush. Any shake rotational or otherwise shall not affect the deflection of the pointer as follows:

a) For 0·01 mm dial gauges by more than the thickness of the graduation line, and

b) For 0·002 mm dial gauges by more than half the width of the division.

4.6 *Zero Setting* — Every dial gauge should have a device allowing the pointer and the zero mark on the dial to be set to correspond for any position of the plunger within its useful travel.

4.7 *Plunger Contact Point* — The plunger contact point shall be easily removable and interchangeable (*see* Fig. 1). It normally shall have a wear resistant end, of spherical form with a radius selected as large as possible. The tip of the contact point shall have a hardness not less than 700 HV [*see* IS : 1501-1978 'Method for vickers hardness test for steel (*first revision*)'].

4.7.1 The screw thread connecting the contact point and the plunger shall be M2·5, 6H/6g.

4.8 *Fixing Devices* — Dial gauges shall be supplied with either a backlug fixing as shown in Fig. 1 or fixing may be affected by clamping the stem of the instrument.

4.8.1 For dial gauges supplied with a backlug fixing, this may be integral with the gauge or may be removable. In each case the backlug shall be nominally square to the plane of the dial gauge and parallel to the axis of the plunger.

4.8.2 For dial gauges without a backlug, fixing the case design shall be such that the freedom of movement of the plunger shall not be impaired by clamping the stem of the instrument, provided that such clamping is carried out in a proper manner.

4.8.2.1 In case of stem clamping, the hole in which the stem is secured, shall be a close round fit when tightened. It is recommended that the tolerance on the size of this hole be H7.

5. Performance Requirements

5.1 *General* — The dial gauge at any position within its complete range of movement shall comply with the requirements of 5.2 to 5.4. Compliance shall be achieved both with and without a lifting device, where fitted without resort to tapping the gauge. Because the dial gauge is primarily designed for the measurement of a small difference in dimensions, they shall not be used for the measurement of large differences with the same order of accuracy. The error over any interval of reading may be either plus or minus and the permissible errors shall not be exceeded for either direction of movement of the pointer.

5.2 *Sensitivity* — Dial gauges shall be free from any trace of stickyness or backlash. They shall therefore be capable of indicating small gradual changes within the accuracies given below:

a) For 0·01 mm dial gauge, for a change of 0·025 mm — 0·003 mm; and

b) For 0·002 mm dial gauge, for a change of 0·005 mm — 0·001 mm.

These are including any hysteresis error that may be there.

5.3 *Repeatability of Reading* — Dial gauges shall repeat their readings under all ordinary methods of operation within the accuracies given in Table 1.

5.4 *Calibration* — Calibration shall take place from the first 12 O'clock position of the pointer unless otherwise specified by the purchaser. The limits of error stated in Table 1 apply to all intervals and are not restricted to those commencing at zero. They also embrace any eccentricity of the dial scale in relation to the axis of rotation of the pointer and the limits shall not be exceeded as a result of any rotation of the bezel.

5.5 *Measuring Force* — The force required to operate the dial gauge shall be as small as practicable and the maximum force for all types of dial gauges shall not exceed 1·5 N. Variations in the measuring force shall not exceed 0·6 N any point in the range of movement of the plunger.

5.5.1 For verification purposes the force shall be applied with the gauge in the vertical position and the contact point downwards.

TABLE 1 PERFORMANCE

(*Clauses* 5.2, 5.3 *and* 5.4)

All dimensions in millimetres.

Requirement		Limits of Error	
		0·01 Dial Gauge	0·002 Dial Gauge
Sensitivity (including hysteresis)	Change of 0·025	0·003	—
	Change of 0·005	—	0·001
Repeatability		0·002	0·0005
Accuracy over an interval of	Any 1/10th rev.	0·005	0·001
	Any 1 rev.	0·010	0·004
	Any 2 revs.	0·015	0·006
	Any larger interval up to 10 revs.	0·020	0·018

Note 1 — For dial gauges over 10 revolutions refer to the individual manufacturer for their standard practice.

Note 2 — By limits of error (total) it is meant that the total error whether it is + or −.

Example:

A 0·01 mm gauge is having + 0·017 mm (*Max* error on the plus side) and — 0·003 mm (*Max* error on the minus side) over its full 10 mm travel, then the cumulative error would be 0·020 mm which is acceptable. In other words, the total error thus obtained should not exceed the above specified limits.

5.6 *Care, Use and Selection of Dial Gauge* — Notes on the care, use and selection of dial gauges are given in Appendix B.

6. Material and Hardness — The broad guidelines for the material and hardness for principal parts of dial are given in Table 2.

TABLE 2 MATERIALS AND HARDNESS FOR PRINCIPAL PARTS

Sl. No.	Parts	Material Conforming to	Hardness
1.	Bezel	Aluminium as per IS : 738-1977 'Wrought aluminium and aluminium alloy drawn tube for general engineering purpose (*second revision*) or brass as per IS : 407-1981 'Brass tubes for general purposes (*third revision*)'.	
2.	Case	Brass as per IS : 3488-1980 'Brass bars, rods and sections suitable for forging (*first revision*)' or zinc alloy 1 as per IS : 742-1981 'Zinc base alloy die castings (*second revision*)'.	
3.	Movement plates	Brass — as per IS : 531-1971 'Leaded brass strip for instrument parts (*first revision*)'.	
4.	Plunger	Grade T110W6 Gr 4 of IS : 3749-1978 'Tool and die steels for cold work (*first revision*)'.	
5.	Contact point	IS : 2898-1976 'Steel balls for rolling bearings (*first revision*)'.	700HV *Min**
6.	Gear wheels	Brass as per IS : 531-1971.	
7.	Gear pinions	Grade T110W6 Gr 4 of IS : 3749-1978.	
8.	Stem	Grade T110W6 Gr 4 of IS : 3749-1978.	
9.	Backlug	Zinc base alloy as per IS : 742-1981.	
10.	Tension spring	IS : 4454 (Part I)-1975 'Steel wires for cold formed springs : Part I Patented and cold drawn steel wires unalloyed (*first revision*)'.	
11.	Hair spring	Grade 2 of IS : 7608-1975 'Phosphor bronze wires (for general engineering purpose)'.	

**See* IS : 1501-1968 'Method for Vickers hardness test for steel (*first revision*)'.

7. Workmanship and Finish

7.1 The coating and plating on all parts shall be uniformally applied and shall be free from easy discolouring, peeling and rusting.

7.2 All working parts shall not produce any inaccuracies deterimental to practical use under normal working temperature and humidity conditions.

7.3 The appearance of principal parts, condition of finish, stamped marks, marking and scales, etc, shall not show any defect.

7.4 When holding the dial gauge in any position, movement of the plunger over its range shall be smooth and without any resistance.

7.5 The rotation of dial shall be smooth and be capable of being fixed at any position.

7.6 For gauges provided with limit pointers, the pointers shall be adjustable simply, correctly and not be easily movable during the measurement.

8. Marking

8.1 Each gauge shall be legibly and permanently marked with the following:

a) Scale interval,

b) Serial number, and

c) Manufacturer's name or trade-mark.

8.2 *ISI Certification Marking* — Details available with the Indian Standards Institution.

APPENDIX A

(*Clause* 2.7)

METHOD OF TEST FOR DIAL GAUGES

A-1. **General** — This appendix gives information on recommended methods of testing the dial gauge.

A-2. **Sensitivity and Hysteresis** — This test should be carried out by firmly clamping the dial gauge in a rigid fixture with the contact point contacting the surface of an eccentric precision mandrel mounted between centers. The actual eccentricity should be determined beforehand with a more sensitive and accurate indicator (like a high quality electronic instrument).

When the mandrel is rotated the dial gauge should indicate the amount of throw to which shall be within the tolerances specified in Table 1. This also provides for the reversal of movement of plunger and therefore takes into account the hysteresis in the dial gauge. The amount of eccentricity should be preferably 0·025 mm for 0·01 mm reading dial gauges and 0·005 mm for 0·002 mm reading dial gauges.

A-3. **Repeatability** — This test should be carried out by firmly clamping the dial gauge in a rigid fixture over a flat surface, such as a Grade A surface plate. A true cylinder is rolled under the contact point several times at different directions both slowly and abruptly at different positions throughout the travel of the gauge. The noted readings should be within tolerances specified in Table 1.

A-4. **Determination of Accuracy** — This test shall be carried out by firmly clamping the dial gauge vertically with the plunger pointing downwards in a fixture. The gauge is held rigidly in line with a calibrated micrometer drum or on a suitable calibrating device.

For the purpose of testing, the pointer and the scale mark of the dial gauge shall be brought in coincidence and the variation in the plunger displacement read off on the micrometer drum/calibrating device.

Series of such readings are taken at suitable intervals throughout the range of the gauge. In principle, these intervals should be every 1/10th revolution of the pointer. But this is not practicable for dial gauges with long ranges of measurement, that, is dial gauges with 5 mm and 10 mm travel. Hence, the intervals of 1/10th revolution should be limited to the first two revolutions of the pointer only.

After the first two revolutions, to keep the number of readings within practicable limits for dial gauges with longer travel, that is, 5 mm and 10 mm, only a limited number of 1/10th revolution reading (say 2) are taken during each revolution of the pointer.

For example: 0·01 mm reading dial gauge.

Division of Dial	0	10	20	30	40	50	60	70	80	90
Turn I	Set	+1	+3	+2	0	−1	+1	+3	+2	+4
Turn II	+1	0	−2	+1	−1	0	+2	−4	−1	+2
Turn III	+4	+1	—	—	—	—	—	—	—	−3
Turn IV	−4	—	—	—	—	—	—	—	—	—
Turn V	+5	+4	—	—	—	—	—	—	—	+1
Turn VI	−2	—	—	—	—	—	—	—	—	—
Turn VII	+2	+4	—	—	—	—	—	—	—	−2
Turn VIII	−5	—	—	—	—	—	—	—	—	—
Turn IX	−4	+2	—	—	—	—	—	—	—	+2
Turn X	+1	—	—	—	—	—	—	—	—	—

The readings should be distributed in the manner shown, that, is taking readings at every 1/10th revolution interval for the first two revolutions which are generally used and should get maximum attention and then for the rest of the travel, readings should be taken at every millimetre with one more reading either before or after.

A-4.1 By setting out the readings in this manner, it is simple matter to compare the results with the limits of error given in Table 2 for this particular type of gauge. Thus it will be seen that the error over the 0·1 mm intervals tested, that is, between any two adjacent readings exceeds the tolerance of 0·005 mm specified for that interval in the following test positions:

TURN II : At 60 and 70, errors in reading are +2 and — 4, hence, the error is of 0·006 mm.

TURN IX : At 0 and 10, errors in reading are — 4 and +2, hence, the error is of 0·006 mm.

On the other hand over intervals of one revolution and two revolutions or the total error on full 10 revolutions, the errors are all within the tolerances allowed. The gauge would be regarded as being unsatisfactory on account of the errors found over some of the 1/10th revolution intervals tested.

A-4.2 If there should be any reasonable doubt at any place during calibration, then readings at every 1/20th revolutions shall be taken around the place of doubt.

A-4.3 In case of any dispute regarding the accuracy of the instrument, the gauge block method of calibration using the mean of at least five measurements over each of the points in dispute should be used.

APPENDIX B

(*Clause* 5.6)

CARE, USE AND SELECTION OF DIAL GAUGES

B-1. General Precautions — A dial gauge is made up of a mechanism similar to that of a clock and therefore requires proper care during use. It is emphasized that test results are obtained when the velocity of the plunger movement is kept minimum. Rough handling should be avoided.

B-2. Lubrication — The plunger is a close running fit in the bush and care should be taken not to lubricate it. Any oil or grease may pick up dust and prevent the function of the light spring.

B-3. Clamping — Whatever means are provided on the dial gauge for clamping purpose, be it a backlug or stem, proper clamping is very essential for getting accurate readings. In each case, particularly in stem clamping, tolerance should be as mentioned in Fig. 1 and 4.8.2.1. The base or the stand on which the clamp is mounted should be heavy and stable to ensure accurate readings.

B-4. Contact Points — Mostly ball type contact points are provided which wear off in case of dial gauges in constant use and become flat. For obtaining better, contact points should be replaced whenever there is appreciable wear. In case of flat contact points, it is important that the flat surface is square with the axis of the plunger.

B-5. Choice of Gauge — This mostly depends on the type of work and accuracy required thereof. A general rule is that for checking dimension to a given accuracy, a dial gauge of next lower unit should be selected. For example, where there is a component with a dimensional accuracy of ±0·01 mm, select a gauge of 0·002 mm unit. In case of a dimensional accuracy of ±0·05 mm it would be sufficient to have a gauge of 0·01 mm unit. Except for workshop use, the dial gauges should be used as comparators rather than direct measuring instrument. To take measurement, the gauge should be set up on a rigid comparator stand to take measurement over slip gauges of correct size, which should be very nearly the same size as that of the work piece to be checked. The same setting as used to check the work pieces and deviations are noted. This provides greater accuracy on work measurement.

B-6. Use of Plunger Lifting Lever — When the plunger is raised by means of a lever to allow work to be inserted under the contact point, it should not be released such that the point hits the work with force. The use of a dial gauge in this way for any length of time will bring about a distortion of the teeth of the plunger. Furthermore, such usage may cause the pointer to slip on its spindle.

B-7. Accuracy During Use — The accuracy limits specified in this standard are acceptance limits for new dial gauges. During use, the dial gauge may loose its accuracy. In such a case, the dial gauge may be certified to be accurate only over a part measuring range and should be used for correcting the readings. However, when the use is restricted to comparison only, such precaution may not be necessary as the dial gauge may be used over a very short range.

EXPLANATORY NOTE

This standard was first published in 1962. At the time of review, the committee responsible for its preparation, felt it necessary to revise the specification to it bring in line with current international practices. In this revision different types, grades and guide for the selection of high precision dial gauge have been ommitted.

For the sake of information and guidance, care, use and selection of dial gauges have been included.

In the preparation of this revision, assistance has been derived from ISO/R 463-1965 'Dial gauges reading in 0·01 mm, 0·001 in and 0·000 1 in'.

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