Vernier callipers
Requirements and testing

DIN 862

Meßschieber; Anforderungen, Prüfung

Supersedes March 1979 edition.

In keeping with current practice in standards published by the International Organization for Standardization (ISO), a comma has been used throughout as the decimal marker.

See Explanatory notes for connection with International Standards ISO 3599 – 1976 and ISO 6906 – 1984 published by the International Organization for Standardization (ISO).

Dimensions in mm

1 Field of application

This standard applies both to analogue vernier callipers with a maximum measuring range from 0 to 2000 mm and a vernier or circular scale graduated in 0,1, 0,05 or 0,02 mm, and to vernier callipers with digitized output over ranges from 0 up to a maximum of 1000 mm in 0,01 mm increments.

2 Terminology

See DIN 2257 Parts 1 and 2 for concepts relating to dimensional metrology, and DIN 1319 Parts 1 to 4 for basic metrological concepts.

3 Designations and dimensions

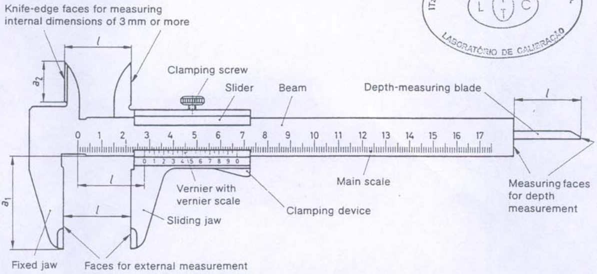
Vernier callipers are not expected to conform to the designs illustrated here; compliance is only required in the case of the dimensions specified.

For general tolerances, accuracy grade m as specified in DIN 7168 shall apply.

3.1 Vernier callipers designed for internal, external and depth measurement

Type 1A, with clamping screw
Type 2A, with clamping device

The above types are normally designed for measuring lengths up to 160 mm.



Dimensions as specified in table 1; indication as per clause 4.

Figure 1. Analogue vernier callipers (with main scale and vernier scale)

Continued on pages 2 to 7

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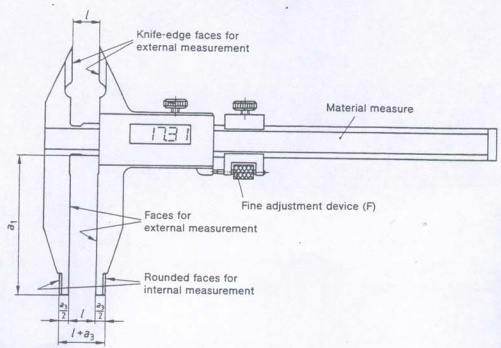
3.2 Vernier callipers designed for internal and external measurement

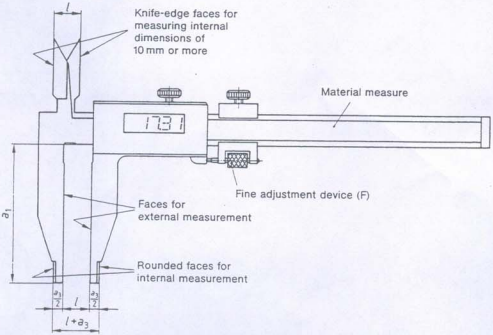
Type B



Other details as in figure 1; dimensions as specified in table 1; indication as per clause 4.

Figure 2. Type B digital vernier callipers with fine adjustment device (F)

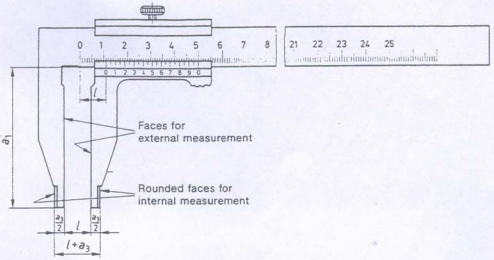
Type D



Other details as in figure 1; dimensions as specified in table 1; indication as per clause 4.

Figure 3. Type D digital vernier callipers with fine adjustment device (F)

Type E

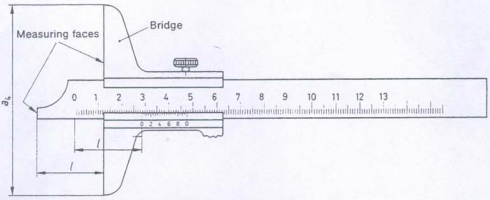


Other details as in figure 1; dimensions as specified in table 1; indication as per clause 4.

Figure 4. Type E analogue vernier callipers (main scale and vernier scale)

3.3 Vernier callipers designed for depth measurement

Type C



Other details as in figure 1; dimensions as specified in table 1; indication as per clause 4.

Figure 5. Type C analogue vernier callipers (main scale and vernier scale)

Table 1. **Dimensions**

Measuring ranges [1] — From 0 to	Preferred projection of jaws, a_1 [2]	Minimum length of faces for internal measurement, a_2	Combined width of jaws for internal measurement, a_3	Preferred bridge length for depth vernier callipers, a_4
160	40	8	5	100
200	60		10	
250	75	10		
300	90			
400	125	15	20	150
500	150			
750				250
1000		20		
1500				–
2000	200	–		

1) The measuring range of vernier callipers fitted with a fine adjustment device may be reduced by the length of the device concerned.

2) The maximum projection of the jaws, a_1, shall be equal to one-third of the measuring range up to an upper limit of 300 mm. In the case of vernier callipers reading to 0,02 mm, the projection should be shorter in order to prevent the results of measurement being unduly distorted as a result of non-compliance with Abbe's principle.

4 Types of indication

4.1 Analogue indication

4.1.1 Line scales

There are two types of line scale indication. The first type (symbol: N) is as illustrated in figure 9: the main scale is on the beam and the vernier with the vernier scale is on the bevelled face of the slider. The second type (symbol: P) is designed to give a parallax-free reading (cf. figure 10), with the main scale on the beam and the vernier with the vernier scale on the horizontal face of the slider.

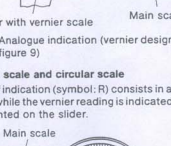


Figure 6. Analogue indication (vernier design as shown in figure 9)

4.1.2 Line scale and circular scale

This type of indication (symbol: R) consists in a line scale on the beam, while the vernier reading is indicated on a circular scale mounted on the slider.

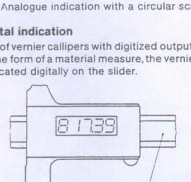


Figure 7. Analogue indication with a circular scale

4.2 Digital indication

The beam of vernier callipers with digitized output (symbol: Z) takes the form of a material measure, the vernier reading being indicated digitally on the slider.

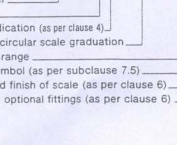


Figure 8. Digital indication

5 Designation

Vernier callipers as specified in this standard shall be designated as shown in the following example:

Vernier calliper DIN 862 – B R – 0,02 – 400 – St 3 F

- Term: Vernier calliper
- DIN number: DIN 862
- Type: B
- Type of indication (as per clause 4): R
- Vernier or circular scale graduation: 0,02
- Measuring range: 400
- Material symbol (as per subclause 7.5): St
- Background finish of scale (as per clause 6): 3
- Symbol for optional fittings (as per clause 6): F

6 Optional features

Vernier callipers may be provided with the following optional features:

a) fine adjustment device (symbol: F);

b) interface (for callipers with digitized output symbol: S).

The background of the scales on the beam and the vernier may be left as it is (code number 1), have a mat chromium-plated finish (code number 2), or the background of the scale on the beam alone (code number 3), or on the vernier alone (code number 4), may have a mat chromium-plated finish.

7 Requirements

7.1 Limits of error

Compliance with the given limits of error shall be checked at the standard reference temperature of 20 °C as specified in DIN 102.

See also DIN 1319 Part 3 with respect to the specification of limits of error.

The limits of error, G, are a function of the measured length, l, and are to be determined on the basis of the equations given below, the values obtained being given to the nearest 0,01 mm in accordance with DIN 1333 Part 2.

It is evident from the above that the limits of error must always be larger than the digital increment or the vernier or circular scale reading, particularly for measurands approaching the upper limit of the measuring range (cf. the notes on the use of vernier callipers in clause 10).

The equations apply for conditions where the direction of the force applied during measurement does not change. Where it does change, and for measurements made with the aid of the depth-measuring blade, the values obtained for the limits of error are to be increased by 20 µm.

Determination of the limits of error for analogue vernier callipers (vernier scale, circular scale) with 0,1 or 0,05 mm scale intervals or vernier readings:

$$G = \left(20 + \frac{l}{10\,\text{mm}}\right)\,\mu\text{m} \geq 50\,\mu\text{m}$$

Determination of the limits of error for vernier callipers with 0,02 mm scale intervals or vernier readings, and for digital vernier callipers:

$$G = \left(22 + \frac{l}{50\,\text{mm}}\right)\,\mu\text{m}$$

Table 2 indicates the limits of error corresponding to specific measured lengths.

7.2 Slider

If clamping is a design feature of the slider, the indication obtained for a given dimension shall not be altered when the slider is clamped to the beam.

In the case of digital callipers, a change in the indication of one increment during clamping is deemed acceptable.

7.3 Jaws

The significant dimension of the jaws for measurement purposes, i.e. their projection, is specified as a function of the measuring range in table 1.

7.4 Fit

The fit between slider and beam shall permit the slider to be moved smoothly over the entire length of the beam.

7.5 Material

Vernier callipers shall be manufactured from either unalloyed steel (St) or stainless steel (nrSt), the grade of the steel being at the discretion of the manufacturer.

Table 2. **Limits of error**

Measured length, l	Limits of error, $G^1)$, in µm		
	Scale interval or vernier reading		Digital increment
	0,1 and 0,05	0,02	0,01
50	50	20	20
100			
200		30	30
300			
400	60		
500	70		
600	80		
700	90	40	40
800	100		
900	110		
1000	120		
1200	140	50	–
1400	160		
1600	180	60	
1800	200		
2000	220		

1) In practical metrology, symmetrical limits of error are the rule, and accordingly are indicated here by a single value. The use of the ± signs to specify the limits of error is now deprecated.

The Vickers hardness of the measuring faces shall be 700 HV 5 (approx. equivalent to Rockwell hardness 59 HRC) in the case of unalloyed steel, and at least 575 HV 5 (approx. equivalent to Rockwell hardness 53 HRC) in the case of stainless steel.

7.6 Analogue vernier callipers

7.6.1 Scale on beam

The intervals of the scale on the beam of callipers with a vernier shall be 1 mm, the length of the scale exceeding that of the nominal measuring range of the calliper by not less than the length of the vernier.

In the case of callipers equipped with circular scales, the scale interval on the beam may be larger than 1 mm.

The scale lines of both beam and vernier shall be sharp-edged and perpendicular to the guiding surface of the beam.

Table 3. **Thickness of scale lines**

Measuring range		Thickness 1)
Over	Up to	
	200	0,08 to 0,12
200	300	0,1 to 0,15
300	2000	0,1 to 0,2

1) Tolerance for the thickness of scale lines on beam and vernier of a given calliper: 30 µm.

The distance between the scale on the beam and the edge of the bevelled graduated face of the vernier shall not exceed 0,3 mm (cf. figure 9).

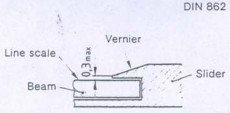


Figure 9. Distance between scales on beam and vernier

The scales on the beam and on the vernier of callipers designed to give a parallax-free reading lie in the same plane (cf. figure 10). The distance between slider and beam of such callipers shall not exceed 0,03 mm.

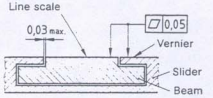


Figure 10. Distance between the scales of callipers designed to give a parallax-free reading

7.6.2 Circular scale

The design of circular scales shall be as specified in DIN 878.

7.7 Digital vernier callipers

7.7.1 Setting speed

The maximum speed with which the slider is to be set in position shall be specified by the manufacturer; the minimum speed shall be 0,5 m/s.

7.7.2 Error notification

The digital indicating device shall be equipped to notify operating and system errors, e.g. to notify that the maximum setting speed is being exceeded or that the power supply is inadequate.

7.7.3 Interface

If digital callipers are provided with an interface, this shall be designed in compliance with a DIN Standard, e.g. with DIN 66 348 Part 1.

8 Testing

8.1 Limits of error

Gauge blocks as specified in DIN 861 Part 1 and setting ring gauges as specified in DIN 2250 Part 2 shall be used to check that the results of measurement lie within the given limits of error. The results are directly influenced by any deviations from flatness or parallelism of the measuring faces.

Although it is recommended that digital vernier callipers be adjusted to the zero setting with their jaws closed prior to testing, the zero may be set at any given position of the jaws as the equations specified in clause 7 apply both to positive and negative directions. Measurements are to be made at random points along the length of the measuring faces, the same force being applied to the slider in each case. Errors in reading are also to be checked by measuring at a number of positions over the measuring range of the calliper so as to ensure that the separate indications involve different figures.

8.2 Thickness of scale lines

The thickness of scale lines shall be checked with the aid of optical measuring instruments.

9 Marking

Vernier callipers shall be marked with the name or symbol of the manufacturer; those which comply with the requirements of this standard may also be marked with the DIN symbol.

10 Notes on use

Vernier callipers, with the exception of type C callipers designed for depth measurements, do not comply with Abbe's principle. Play in the movement of the slider, and strong pressure on the sliding jaw when in contact with the object to be measured, cause the slider to tilt. That gives rise to distortions which influence the results and the uncertainty of measurement. In order to minimize such influences, the object to be measured shall be held between the faces of the jaws close to the beam.

The limits of error have been made a function of length instead of being specified solely by way of a constant, as this gives more realistic values, particularly for the longer measured lengths. The effects of temperature and strain intensify the influence of length on the error in reading. This means that the smallest realizable uncertainty of measurement is greater than that which may be assumed from the smallest indicated fraction of a millimetre. Due allowance shall be made for this when assessing the last fractions of a millimetre of the result of a measurement.

The uncertainty of measurement may be reduced by way of calibration, which involves measurements being made on comparison standards (e.g. gauge blocks as specified in DIN 861 Part 1 for external measurement, and setting ring gauges as specifed in DIN 2250 Part 2 for internal measurement).

When using vernier callipers with digitized output, it should be remembered that ambient influences such as magnetic fields, electrical fields, or humidity, may impair the function of the instrument or irreparably damage electronic components.

Standards referred to

DIN	102	Reference temperature of measuring tools and workpieces
DIN	861 Part 1	Gauge blocks; concepts, requirements and testing
DIN	878	Dial gauges
DIN	1319 Part 1	Basic concepts in metrology; general concepts
DIN	1319 Part 2	Basic concepts in metrology; terminology relating to the use of measuring instruments
DIN	1319 Part 3	Basic concepts in metrology; terminology relating to the uncertainty of measurement and the assessment of measuring instruments and measuring equipment
DIN	1319 Part 4	Basic concepts in metrology; treatment of uncertainties in the evaluation of measurements
DIN	1333 Part 2	Presentation of numerical data; rounding
DIN	2250 Part 2	GO ring gauges and setting ring gauges from 1 to 315 mm nominal diameter for precision engineering
DIN	2257 Part 1	Terminology used in dimensional metrology; units, procedures, checking instruments; metrological concepts
DIN	2257 Part 2	Terminology used in dimensional metrology; practice; measurement errors and uncertainties
DIN	7168 Part 1	General tolerances; linear and angular dimensions
DIN	66348 Part 1	Interfaces and basic data link control procedures for serial measurement data communication; start-stop-transmission, point-to-point connection

Previous editions

DIN 862: 12.29x, 12.60, 03.79.

Amendments

The following amendments have been made to the March 1979 edition.

a) Digital vernier callipers reading in 0,01 mm increments have been included.

b) Vernier callipers with vernier or circular scale reading to 0,02 mm (1/50 mm vernier callipers) have been included.

c) The term 'permissible deviation of indication' has been replaced by 'limit of error' and different values have been specified for the latter (cf. Explanatory notes).

d) Type D and type E callipers have been introduced.

e) The standard designation has been introduced.

f) Clause 10 has been included.

g) Specifications with regard to the background finish of the scales have been adopted.

h) The tolerances on flatness, straightness and parallelism previously specified for the measuring faces have been dropped (cf. Explanatory notes).

Explanatory notes

This standard is in partial agreement with International Standards ISO 3599 – 1976, Vernier callipers reading to 0,1 and 0,05 mm and ISO 6906 – 1984, Vernier callipers reading to 0,02 mm. The main differences between this standard and the ISO Standards are that:

a) ISO 3599 sets the upper limit of the measuring range at 1000 mm, and ISO 6906 sets it at 500 mm;

b) specifications for vernier callipers with digitized output or circular scales are not included in the ISO standards;

c) neither ISO Standard includes a vernier calliper designed specifically for depth measurement.

Vernier callipers with a vernier reading to 0,02 mm (1/50 mm vernier callipers) have been included in the present standard at the request of the calliper manufacturers.

The limits of error specified here are largely equivalent to the accuracy requirements specified for 1/50 vernier callipers in the December 1929 edition of DIN 862. They are obtained from a constant and a length-dependent component. This method makes due allowance for the fact that, while the minimum value for the limits of error is a function of the specific design of the calliper, there are other influences leading to errors in reading which are proportional to length (e.g. curvature of the beam).

For vernier callipers with vernier or circular scales reading to 0,1 and 0,05 mm, the minimum value for the limits of error has been specified as 50 µm (i.e. 0,05 mm scale intervals) because the value of 40 µm given in table 3 in the March 1979 edition of DIN 862 cannot be read from callipers of this type.

A number of tolerance specifications have been dispensed with, such as the tolerances on flatness, straightness and parallelism of the measuring faces. The responsible committee was of the opinion that it is up to the manufacturer to make sure that the limits of error are complied with and that the design details by which such compliance may be achieved do not fall within the scope of this standard.

A new system has been introduced for designating vernier callipers by way of symbols. The new symbols are not in conflict with those given in the March 1979 edition of the standard. However, as the symbol B3 was used in that edition for callipers with verniers fitted with a fine adjustment device, the number 3 could not be used here for digital vernier callipers. Hence, such callipers are designated by the number 4. The fine adjustment facility is now no longer treated as a separate design, but can be combined with all types, the symbol F indicating that it is fitted. The number 3 has been disregarded for designation purposes.

International Patent Classification

G 01 B 3/20